

PROJECT REPORT

GeoDigital #: 368_SSD12-1

Project Name: South Dakota LiDAR

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Presented to:

State of South Dakota
Pierre, SD

Submitted by:



Lompoc, California

EXECUTIVE SUMMARY

The purpose of this LiDAR project was to provide high accuracy, classified multiple return LiDAR for approximately 11,000 square miles in twenty counties in South Dakota. This project supports the Statewide LiDAR initiative. The LiDAR data were acquired and processed by GeoDigital International and the primary deliverable products are classified LiDAR and hydro-flattened DEMs.

The elevation data was verified internally prior to delivery to ensure it met fundamental accuracy requirements when compared to static GeoDigital International GPS checkpoints. Below are the test summaries:

Ground Kinematic Fundamental

- The LiDAR dataset was tested to 0.091m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.047m x 1.960) when compared to 20,239 GPS kinematic check points.

Ground Static Fundamental

- The LiDAR dataset was tested to 0.128m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.065m x 1.960) when compared to 17 GPS static check points.

Long Grass Static Supplemental

- The LiDAR dataset was tested to 0.069m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.0135m x 1.960) when compared to 42 GPS static check points.

Short Grass Static Supplemental

- The LiDAR dataset was tested to 0.141m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.072m x 1.960) when compared to 40 GPS static check points.



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All data delivered met or exceeds GeoDigital International deliverable product requirements as set out by GeoDigital International *I-PROVE* program.

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PROJECT REPORT

1. Introduction

LiDAR data is remotely sensed high-resolution elevation data collected by an airborne collection platform. By positioning laser range finding with the use of 1 second GPS with 100 Hz inertial measurement unit corrections; GeoDigital International LiDAR instruments are able to make highly detailed geospatial elevation products of the ground, man-made structures and vegetation.

The LiDAR ground extraction process takes place by building an iterative surface model. This surface model is generated using three main parameters: building size, iteration angle and iteration distance.

The purpose of this LiDAR data was to produce high accuracy 3D terrain geospatial products to support the Statewide LiDAR initiative.

This report covers the mission parameters and details, processing step outlines, and deliverables. GPS validation reports and the *Geodetic Control Survey Report* are included as addenda to this report.



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2. Project Boundary





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County Name	Area (sq. km)	Area (sq. mi)
Beadle	3273.51	1263.91
Clay	1079.10	416.64
Codington	1765.65	681.72
Hanson	1127.39	435.29
Miner	1480.65	571.68
Sanborn	1475.84	569.83
Spink	3907.86	1508.83
Turner	1598.78	617.29
Union	1209.85	467.12
Yankton	1378.94	532.41
Roberts	254.43	98.24
Grant	244.92	94.56
Deuel	648.89	250.54
Brookings	1208.51	466.61
Moody	977.84	377.55
McCook	746.78	288.33
Kingsbury	1490.46	575.47
Clark	1170.49	451.93
Davison	1130.47	436.48
Hutchinson	2108.05	813.92
Total	28277.49	10936.97

Table1: LiDAR area breakdown per County

3. LiDAR Acquisition

3.1. LiDAR Systems

GeoDigital deployed three ALTM LiDAR sensors for the data acquisition of this project. The 100 kHz LiDAR system is a state-of-the-art system that enables the combination of accuracy and rapid collection speed due to its high scanning rate. Sensors were OPTECH 3100EA.

The Optech systems were mounted aboard a, A Cessna 310 Tail number N103RM, Piper Chieftain tail number N931SA and a Piper Navaho aircraft, registered as N59936.

GeoDigital ensured that the point density and accuracy specification was maintained throughout the data collection and delivery process.

The table below represents a list of the salient features and characteristics for the Optech ALTM 3100 EA system:

CHARACTERISTIC	ALTM 3100EA
Manufacturer	Optech
Platform	Fixed-wing/Helicopter
Scan principle/pattern	Sawtooth, uniform across 96% of swath
Wavelength(s) (μm)	1.064
Scan angle θ (°)	Variable from 0° to +/- 25°
Pulse rate (kHz)	0 – 100
Scan rate (Hz)	70
Flying height h minimum-maximum (m)	80 – 3500
Swath width (m)	Variable from 0 to 0.93 x altitude (m)
Beam divergence (mrad)	Dual divergence 0.3 or 0.8
Laser footprint (m)	0.75 @ 1000 m h (typical)
Across track point spacing (m)	Variable
Along track point spacing (m)	Variable
Point density (points/ sq. m)	Variable
Flying speed typical (km/h)	250
Area/h (sq. km/h)	Varies
Net flying time max/typical (h)	Typical at 7 hours
No. of echoes per pulse	4 including last
Intensity recording	Yes
Cameras	None currently
Ground GPS receivers (dual-frequency)	Any geodetic grade
Airborne GPS receiver (dual-frequency)	Geodetic grade dual frequency
IMU Manufacturer	Litton

CHARACTERISTIC	ALTM 3100EA
IMU Frequency (Hz)	200
Attitude precision roll, pitch/heading (°)	0.005 / 0.008
Laser classification	Class IV
Eye-safe range (m)	70 (in flight)
Power requirements	28 VDC @ 35 A (maximum)
Operating temperature (°C)	-10° to +35°
Humidity (%)	0 to 95 non-condensing
Sensor dimensions (cm)	16 (w) x 19 (d) x 57 (h)
Sensor weight (kg)	23
Sensor mount	Directly to floor or to adapter for existing camera mount
Control rack	Single rack
Control rack dimensions (cm)	65 (w) x 59 (d) x 49 (h)
Control rack weight (kg)	53
Data storage/acquisition duration	Removable hard-drive

3.2. LiDAR System Parameter Overview

The LiDAR data was acquired using the following system configuration:

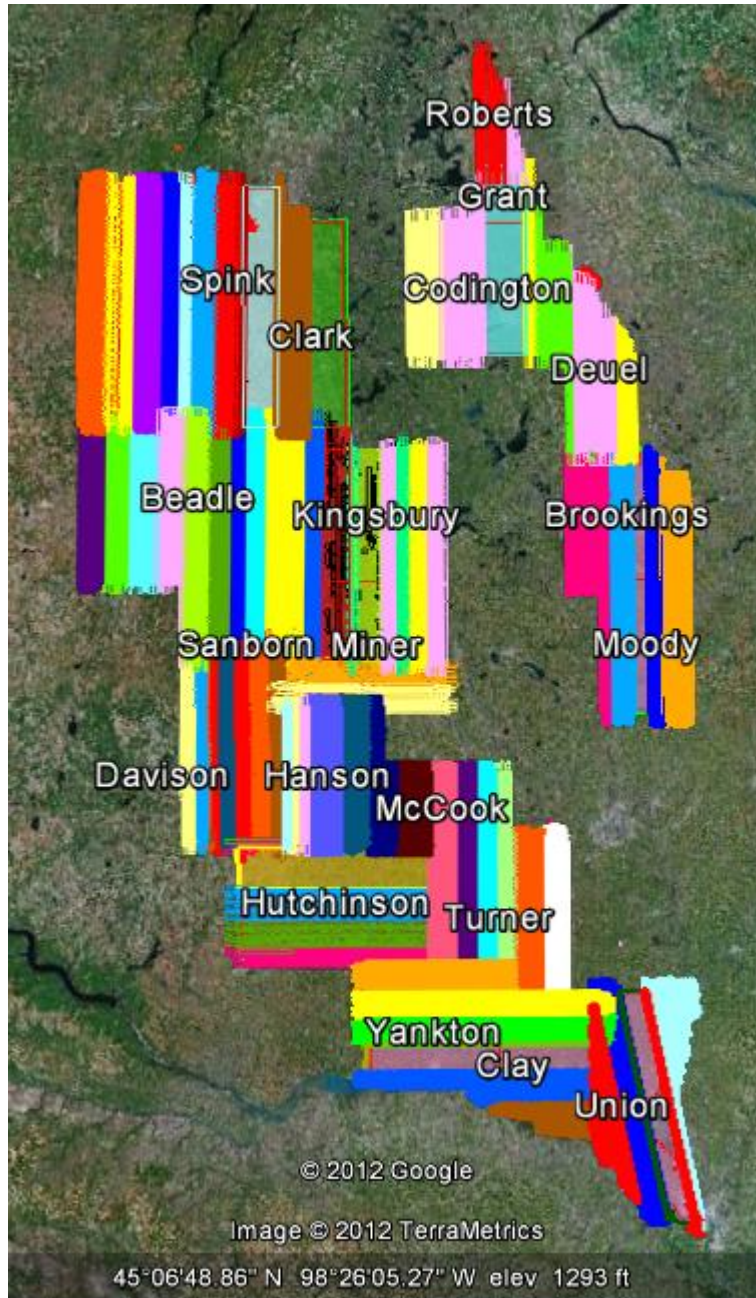
Item	Parameter	Units
Aircraft Speed	150	knots
Data Acquisition Height	1300	m AGL
Overlap	20-25	%
Scanner Field Of View	22	+/- degrees
Pulse Repetition Rate	70	KHz
Scan Frequency	36	Hz
Number of Returns Per Pulse	4	Discrete returns
Beam Divergence set to	narrow	setting
Flight Line Length	85	<X km
Base Station Distance	40	<X km
Resultant Raw Point Density	0.86	pt./m2 excluding overlap

3.3. Base Station and Control GPS Receivers

A combination of Sokkia GSR 2600 and NovAtel DL-4+ dual-frequency GPS receivers were used to support the airborne operations of this survey.

3.4. Missions Statistics

A total of 91 missions acquired were acquired between April 3rd and May 16th as well re-flights on October 20th to provide complete coverage on this project. LiDAR flightlines were flown in multiple orientation blocks designed to best optimize flying time considering the layout for the project.



3.5. Horizontal and Vertical Reference Coordinate System Used

Ten existing published NGS survey monuments (QQ0640, AC7987, PR1071, PR1027, AC7894, AC8003, OQ1162, AC7935, AC7901, AC7967) were observed in a GPS control network and used to establish six new points (368SSD-01,

368SSD-02, 368SSD-03, 368SSD-04, 368SSD-05, 368SSD-06) for the primary control for this site was observed and used to control all flight missions and static ground surveys. The following are the final coordinates of the control points used for this project:

Station	Latitude (D M S)	Longitude (D M S)	Easting UTM14 (m)	Northing UTM14 (m)	H-Ell (m)	H-MSL (m)
Eastern Block						
368SSD04	45 00 20.58849	-97 03 31.99780	652974.1137	4985418.5658	534.6677	559.8598
AC7987	44 53 25.34832	-97 04 33.95021	651921.9851	4972572.9879	502.2003	527.2942
PR1027	44 07 35.76383	-96 45 31.27495	679314.1622	4888376.8313	487.2161	513.0131
PR1071	44 31 53.59693	-96 45 23.46303	678256.4018	4933362.3296	509.1699	534.2054
QQ0640	45 18 59.38662	-97 02 59.00412	652862.7551	5019960.2246	589.6721	614.9944
Western Block						
368SSD01	44 16 04.38891	-97 33 06.78382	615578.0569	4902646.6456	474.0593	499.3552
368SSD02	44 11 03.94262	-98 17 28.79747	556640.5261	4892601.3829	375.7676	401.0253
368SSD03	44 37 58.96122	-98 18 05.66949	555396.8317	4942424.8609	370.3693	394.8881
368SSD05	43 42 07.73595	-98 08 51.49130	568678.5464	4839145.0029	388.6436	414.8141
368SSD06	43 24 00.35765	-97 41 41.48358	605687.7767	4806073.8534	375.8463	402.0193
AC7894	45 09 22.94129	-98 22 35.00332	549016.1436	5000510.7875	371.6924	396.1318
AC7901	43 04 57.50468	-97 24 35.58390	629435.0083	4771218.9022	381.7834	407.5541
AC7935	43 27 08.77688	-97 07 20.90758	651907.9103	4812771.3508	387.4296	413.6162
AC7967	42 51 02.63635	-96 36 31.55852	695381.0046	4747012.7324	328.9431	354.5871
AC8003	44 53 33.72036	-98 02 38.93507	575476.2048	4971475.2176	395.901	420.3459
KFSD	43 35 02.99664	-96 44 09.87836	682773.2995	4828178.8605	406.7137	433.0136
OQ1162	43 39 58.08709	-97 43 45.64136	602443.5728	4835576.7017	389.1169	415.1584

The published horizontal datum of the stations is NAD83 (NSRS) and the vertical datum is NAVD88

The projection used for all deliverables was Universal Transverse Mercator (UTM), Zone 14 and the units are metres.

For further details concerning the control used in this project including the network adjustment, please see the *Geodetic Control Survey Report* in Appendix B.

3.6. Geoid Model Used

All elevations were referenced to the GEOID09 model, published by National Geodetic Survey (NGS), which was used to reduce all ellipsoidal heights to orthometric.

3.7. Data Coverage

On a mission and project level, a daily coverage check is performed in the field as per GeoDigital International *I-Prove* requirements and no data voids were detected unless caused by natural features such as open water.

4. LiDAR Processing

4.1. Airborne GPS Kinematic

Airborne GPS kinematic data was processed on-site using GrafNav kinematic On-The-Fly (OTF) software. Flights were flown with a minimum of 6 satellites in view (13° above the horizon) and with a PDOP of better than 3.5. Distances from base station to aircraft were kept to a maximum of 40km.

For all flights, the GPS data can be classified as excellent, with average GPS residuals of 3 or better but no larger than 10 cm being recorded.

4.2. Generation and Calibration of Laser Points (raw data)

The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete.

Subsequently the mission points are output using Optech's Dashmap, initially with default values from Optech or the last mission calibrated

for system. The initial point generation for each mission calibration is verified within MicroStation/TerraScan for calibration errors. If a calibration error greater than specification is observed within the mission, the roll pitch and scanner scale corrections that need to be applied are calculated. The missions with the new calibration values are regenerated and validated internally once again to ensure quality. All missions are validated against the adjoining missions for relative vertical biases and collected GPS kinematic validation points for absolute vertical accuracy purposes.

On a project level, a supplementary coverage check is carried out, to ensure no data voids unreported by Field Operations are present.

4.3. Data Classification and Editing

The data was processed using the software TerraScan, and following the methodology described herein. The initial step is the setup of the TerraScan project, which is done by importing project defined tile boundary index encompassing the entire project areas. The acquired 3D laser point clouds, in LAS binary format, were imported into the TerraScan project and divided into file size optimized tiles. Once tiled, the laser points were classified using a proprietary routine in TerraScan. This routine removes any obvious outliers from the dataset following which the ground layer is extracted from the point cloud. The ground extraction process encompassed in this routine takes place by building an iterative surface model.

This surface model is generated using three main parameters: building size, iteration angle and iteration distance. The initial model is based on low points being selected by a "roaming window" with the assumption is that these are the ground points. The size of this roaming window is determined by the building size parameter. The low points are triangulated and the remaining points are evaluated and subsequently added to the model if they meet the iteration angle and distance constraints. This process is repeated until no additional points are added within iteration.

A second critical parameter is the maximum terrain angle constraint, which determines the maximum terrain angle allowed within the classification model. The data is then manually quality controlled with

the use of hillshading, cross-sections and profiles. Any points found to be of class vegetation, building or error during the quality control process, are removed from the ground model and placed on the appropriate layer. An integrity check is also performed simultaneously to verify that ground features such as rock cuts, elevated roads and crests are present. Once data has been cleaned and complete, it is then verified by a supervisor via manual inspection and through the use of a hillshade mosaic.

4.4. Deliverable Product Generation

The following products were delivered as per the consulting contract

4.4.1. Metadata

- Collection Report detailing mission planning and flight logs.
- Survey Report detailing the collection of control and reference points used for calibration and QA/QC.
- Processing Report detailing calibration, classification, and product generation procedures including methodology used for breakline collection and hydro-flattening
- QA/QC Reports (detailing the analysis, accuracy assessment and validation of:
 - The point data (absolute, within swath, and between swath)
 - The bare-earth surface (absolute)
 - Other optional deliverables as appropriate
- Control and Calibration points: All control and reference points used to calibrate, control, process, and validate the LiDAR point data or any derivative products are to be delivered.
- Geo-referenced, digital spatial representation of the precise extents of each delivered dataset. This reflects the extents of the actual LiDAR source provided in SHP format.
- Product metadata (FGDC compliant, XML format metadata). One file for each:
 - Project
 - Lift
 - Individual tiles for all products

4.4.2. Tiling Scheme

- Tiled deliverables conform to the tiling scheme, without added overlap.
- Tiled deliverables edge-match seamlessly and without gaps in both the horizontal and vertical.
- Tile Naming Convention: Tiles will be named based on southwest corner of the 1,000 m x 1,000 m US National Grid square. Tile naming convention for USNG Zone 14 was logically extended east to cover the USNG Zone 15 area.
Example: 14S PJ 2590
Where: 3 digit Grid Zone Designation, i.e. 14S
100,000-m Square Identification, i.e. P3

2 digit West corner of 5,000 m grid, i.e. 25
2 digit South corner of the 5,000 m grid, i.e. 90

4.4.3. Raw Point Cloud

- All returns, all collected points, fully calibrated and adjusted to ground, by swath.
- Fully compliant LAS v1.2, Point Record Format 1
- Georeference information was included in all LAS file headers
- GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each pulse.
- Intensity values (native radiometric resolution)
- 1 file per swath, 1 swath per file, file size not to exceed 2GB for long swaths.

4.4.4. Classified Point Cloud

- Fully compliant LAS v1.2, Point Record Format 1
- Georeference information was included in LAS header
- GPS times were recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each pulse.
- Intensity values (native radiometric resolution)
- Tiled delivery, without overlap

4.4.4.1. Classification Scheme

Code Description

1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high)
9	Water
10	Ignored Ground (Breakline Proximity)
11	Withheld
17	Overlap, unclassified
18	Overlap, bare-earth ground
23	Overlap, noise
24	Overlap, water

4.4.5. Bare Earth Surface (Raster DEM)

- 1 meter Cell Size
- Delivery was provided in 32-bit floating point raster format (ERDAS .IMG)
- Georeference information was included in each raster file
- Tiled delivery, without overlap
- QC was performed to ensure DEM tiles show no edge artifacts or mismatch.
- Void areas (i.e., areas outside the project boundary but within the tiling scheme) were coded using a unique "NODATA" value as per the requirements
- Vertical Accuracy of the bare earth DEM was assessed and reporting is provided in the Positional Accuracy (Section 6)

- Depressions (sinks), natural or man-made, were not filled.
- Water Bodies (ponds and lakes), wide streams and rivers (“double-line”), and other non-tidal water bodies as defined in Section 5.6 were hydro flattened within the DEM. Hydro-flattening shall be applied to all water impoundments, natural or man-made, that are larger than ~3/4 acre in area (equivalent to 3,000 square meters in area), to all streams that are nominally wider than 50’, and to all non-tidal boundary waters bordering the project area regardless of size.

4.4.6. First Return Surface (Raster DEM)

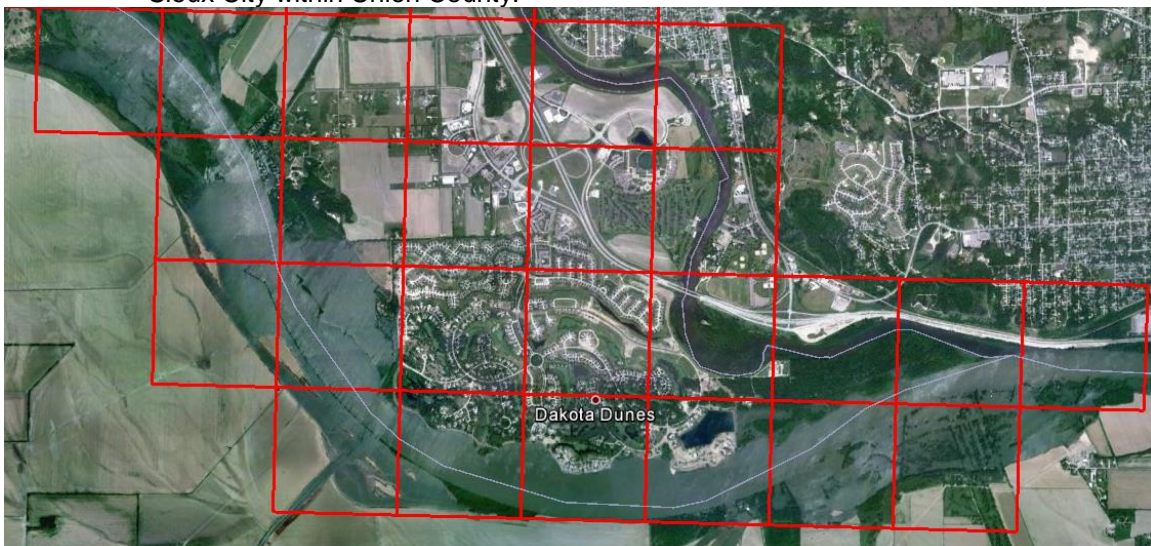
- 1 meter Cell Size
- Delivery was provided in 32-bit floating point raster format (ERDAS .IMG)
- Georeference information was included in each raster file
- Tiled delivery, without overlap

4.4.7. Hydro Polygon Breaklines (as per section 9 of Contract Work Plan)

- All breaklines developed for use in hydro-flattening were delivered in DGN format
- Breaklines used the same coordinate reference system (horizontal and vertical) and units as the LiDAR point delivery.
- Breakline delivery was a continuous layer for each county.

4.4.8. Pilot Area

- To ensure conformance to project specifications and stakeholders’ expectations, a pilot area was provided. The pilot area consisted of sixteen tiles and was representative sample of a mixed urban, vegetated area with the appropriate LAS and DEM. Acceptance of the pilot areas was received prior to proceeding with the remainder of the processing. The area selected was the Dakota Dunes area west of Sioux City within Union County.



5. Quality Control

5.1. Quality Control

The acquisition of overlapping calibration lines for every mission is key to the QC process since it helps identify any systematic issues in data acquisition or failures on the part of the GPS, IMU or other equipment that may not have been evident to the LiDAR operator during the mission.

Ground truth validation is used to assess the data quality and consistency over sample areas of the project. To facilitate a confident evaluation, existing survey control is used to validate the LiDAR data. Published survey control, where the orthometric height (elevation) has been determined by precise differential levelling or GPS observation, is deemed to be suitable.

Ground truth validation points may be collected for each of the terrain categories to establish RMSE accuracies for the LiDAR project. These points must be gathered in flat or uniformly sloped terrain (<20% slope) away from surface features such as stream banks, bridges or embankments. If collected, these points will be used during data processing to test the RMSE_z accuracy of the final LiDAR data products.

The Field Project Manager performs kinematic post-processing of the aircraft GPS data in conjunction with the data collected at the Reference Station. Double difference phase processing of the GPS data is used to achieve the greatest accuracy. The GPS position accuracy is assessed by comparison of forward and reverse processing solutions and a review of the computational statistics. Any data anomalies are identified and the necessary corrective actions are implemented prior to the next mission.

The quality control of the data products has proven to be a key concern by GeoDigital International clients. Many specifications detail how to measure the quality of data given RMSE statistical methods to a 95% confidence level. In order to assure meeting all levels of QC concerns, GeoDigital International has quality control and assurance steps in both the data acquisition phase and the data processing phase. Any acquired data sets that fail these checks are flagged for re-acquisition.

5.1.1. System Logger – Power Up Health Checks

The system logging software performs automatic system and subsystem tests on power-up to verify proper functionality of the entire data acquisition system. Any anomalies are immediately investigated and corrected by the operator if possible. Any persistent problems are referred to the engineering staff, which can usually resolve the issue by telephone and/or email. In the unlikely event that these steps do not resolve the problem, a trained engineer is immediately dispatched to the project site with the appropriate test equipment and spare parts needed to repair the system.

5.1.2. System Logger – Real Time Acquisition Checks

The system logging software continuously monitors the health and performance of all subsystems. Any anomalies are recorded in the System Log and reported to the operator for resolution. If the operator is unable to correct the problem, the engineering staffs are immediately notified. They provide the operator with instructions or on-site assistance as needed to resolve the problem.

If any aspect of the data does not appear to be acceptable, the operator will review system settings to determine if an adjustment could improve the data quality. Navigation aids are provided to alert both the pilot and operator to any line following errors that could potentially compromise the data integrity. The pilot and operator review the data and determine whether an immediate re-flight of the line is required.

5.1.3. Post-Acquisition Data Check

After the mission is completed, the raw data on the removable disk drive is transferred to the Field PC at the field operations staging area. An automated QA/QC program scans the System Log as well as the raw data files to detect potential errors. Any problems identified are reported to the operator for further analysis. Data is also retrieved from all GPS Reference Stations, which were active during the mission and transferred to the Field PC. The GPS data is processed and tested for internal consistency and overall quality.

Any errors or limit violations are reported to the operator for more detailed evaluation.

5.1.4. Data Viewer Analysis

The Field Project Manager utilizes a data viewer installed on the Field PC to review selected portions of the acquired raw data, this permits a more thorough and detailed analysis of the data corrupted files or problems in the data itself are noted. If the data indicates improper settings or operation of the sensors, the Field Project Manager determines the appropriate corrective actions needed prior to the next mission.

5.1.5. Data Backup with Redundancy

All acquired raw data is copied from the Field PC onto two separate removable hard drives: one for transfer to QA/QC, and one for local backup. Each hard drive is reviewed to ensure data completeness and readability.

5.2. Quality Control for Data Processing

Quality assurance and quality control procedures for the raw data and derivative products are performed in an iterative fashion through the entire data processing cycle. All final products pass through a six-step QC control check to verify that the data meets the criteria specified by GeoDigital International.

The following list provides a step-by-step explanation of the process used by GeoDigital International to review the data prior to customer delivery.

5.2.1. LiDAR Calibration

5.2.1.1. Calibration Setup and Data Inventory

Data collected by the LiDAR unit is reviewed for completeness and to make sure all data is captured without errors or corrupted values. In addition, all GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

5.2.1.2. Boresight

The LiDAR data is post processed and calibrated as a preliminary step for product delivery initially with default values from the sensor system manufacturer or the last mission calibrated for the system. The initial point generation for each mission calibration is inspected for flight line errors, flight line overlap, slivers or gaps in the data, point data minimums, or issues with the sensor unit. If a calibration error greater than the project specification is observed within the mission, the roll, pitch and scanner scale corrections that need to be applied are calculated. The missions with the new calibration values are regenerated and validated internally once again to ensure quality. Flight line swath overlap is confirmed to the adjacent flight lines at the tolerance specified by the client for overlap throughout the project area thus enabling an evaluation of data reproducibility throughout the areas.

5.2.2. Calibrated Ground Truth Validation

A preliminary RMSE_z error check is performed at this stage of the project life cycle in the raw dataset against GPS static and kinematic data and compared to RMSE_z project specifications. The LiDAR data is examined in open, flat areas away from breaks and under specified vegetation categories. This step is repeated in production against the final bare earth LiDAR model.

5.3. LiDAR Production

5.3.1. Production Setup Quality Control

Once the data enters the bare earth extraction stage, a checklist verifying all the components of the project have been received in good order.

5.3.2. Ground Extraction Quality Control

Once the raw LiDAR data is ready for the bare earth extraction stage, all points are classified as ground and non-ground features and the subsequent quality control takes place to ensure an accurate data set is produced:

- The non-ground LiDAR point cloud product is reviewed as LiDAR points and/or surface and attention is placed on locating and eliminating any outlier or anomalous points beyond three-sigma values. LiDAR points returning from low clouds, birds, pollution, or noise in the system can cause spikes. Pit-like low returns can come from returns on building windows (corner reflectors) or from system noise. Either type of point needs to be classified as an error point and eliminated from use by any DEM or derivative products. In addition to these outliers, the non-ground LiDAR point cloud is reviewed for regular looking non-surface errors like scan lines appearing in the data. Also, any localized errors remaining between flight lines are measured and adjusted as needed.
- Unusual or odd-looking features and questionable returns are checked for validity and compared against additional source material such as aerial photos, USGS digital maps, local maps, or by field inspection. Most errors found at this QC step can be resolved by re-calibration of the data set or by eliminating specific problem points.
- Any valid non-ground LiDAR points representing vegetation, buildings and non-regular structures or features like radio towers, water bodies, bridges, piers, are confirmed to be classified into the category specified by the client for these feature types. Additional data sets like commercially available data sources or data sources provided by the client may be used to assist and verify that points are assigned into correct classifications.
- After the non-ground LiDAR points are certified as passing for completeness and for the removal of outliers, attention is shifted to quality controlling the bare earth model. This product may take several iterations to create it to the quality level that the client is looking for. As GeoDigital International and the client inspect the bare earth model, adjustments are made to fine tune and fix specific errors.
- Adjustments to the bare earth model are generally made to fix errors created by over aggressive bare earth extraction

algorithm results along mountaintops, shorelines, or other areas of high percent slope. Also, vegetation artefacts leave a signature surface that appears bumpy or rough. Every effort is made to remove any vegetation remnants from the bare earth model. All adjustments are made by re-classifying points from ground to non-ground or vice versa. All adjustments are made to the LiDAR points and not gridded products to achieve the highest quality results.

5.3.3. Final Bare Earth Ground Truth Validation

RMSE_z is inspected in the bare earth model and compared to project specifications. RMSE_z is examined in open, flat areas away from breaks and under specified vegetation categories. All accuracy results are reported to the 95% confidence interval for the different categories as available and required. A point comparison of a recently acquired or existing high confidence ground survey point to a TIN generated from the bare earth LiDAR surface. The tolerance for comparisons of control data to the LiDAR TIN elevation is that all sides of the TIN triangle must not be longer than 4.5m to ensure an accurate comparison of surface to the discrete points.

6. Positional Accuracy

6.1. Vertical Positional Accuracy

Prior to delivery the elevation data was verified internally to ensure it met fundamental accuracy requirements of 24.5cm vertical accuracy at the 95% confidence level in open, non-vegetated terrain (2 sigma = RMSE * 1.96) when compared to GeoDigital International kinematic and static GPS checkpoints.

Data is compiled to meet 1.04m horizontal accuracy at the 95% confidence level in open, non-vegetated terrain (2 sigma = RMSE * 1.96)

Below are the test summaries:

Ground Kinematic Fundamental

- The LiDAR dataset was tested to 0.091m vertical accuracy at 95% confidence level based on consolidated RMSE_z (0.047m x 1.960) when compared to 20,239 GPS kinematic check points.

Ground Static Fundamental

- The LiDAR dataset was tested to 0.128m vertical accuracy at 95% confidence level based on consolidated RMSE_z (0.065m x 1.960) when compared to 17 GPS static check points.

Long Grass Static Supplemental

- The LiDAR dataset was tested to 0.069m vertical accuracy at 95% confidence level based on consolidated RMSE_z (0.0135m x 1.960) when compared to 42 GPS static check points.

Short Grass Static Supplemental

- The LiDAR dataset was tested to 0.141m vertical accuracy at 95% confidence level based on consolidated RMSE_z (0.072m x 1.960) when compared to 40 GPS static check points.

A detailed comparison is provided in *Appendix A - GPS Validation*.

7. Issues and Resolutions

A later than expected notice to proceed date, the addition of counties subsequent to mobilization and poor weather during the acquisition period resulted in a completion date that was beyond the contractual requirement. GeoDigital performed and provided to the State daily vegetation analysis and penetration to ground to ensure that project standards were met in a consistent manner.

The higher than expected data volume resulted in a longer processing timeline to ensure data quality and accuracy requirements were met in a consistent manner.

Due to crashed processing timeline an additional processing subconsultant had to be contracted to complete the eastern counties of the project in an effort to maintain the original project timeline. The geographical break between counties provided a logical divide between areas assigned to respective consultants; hence no edge matching issues occurred.

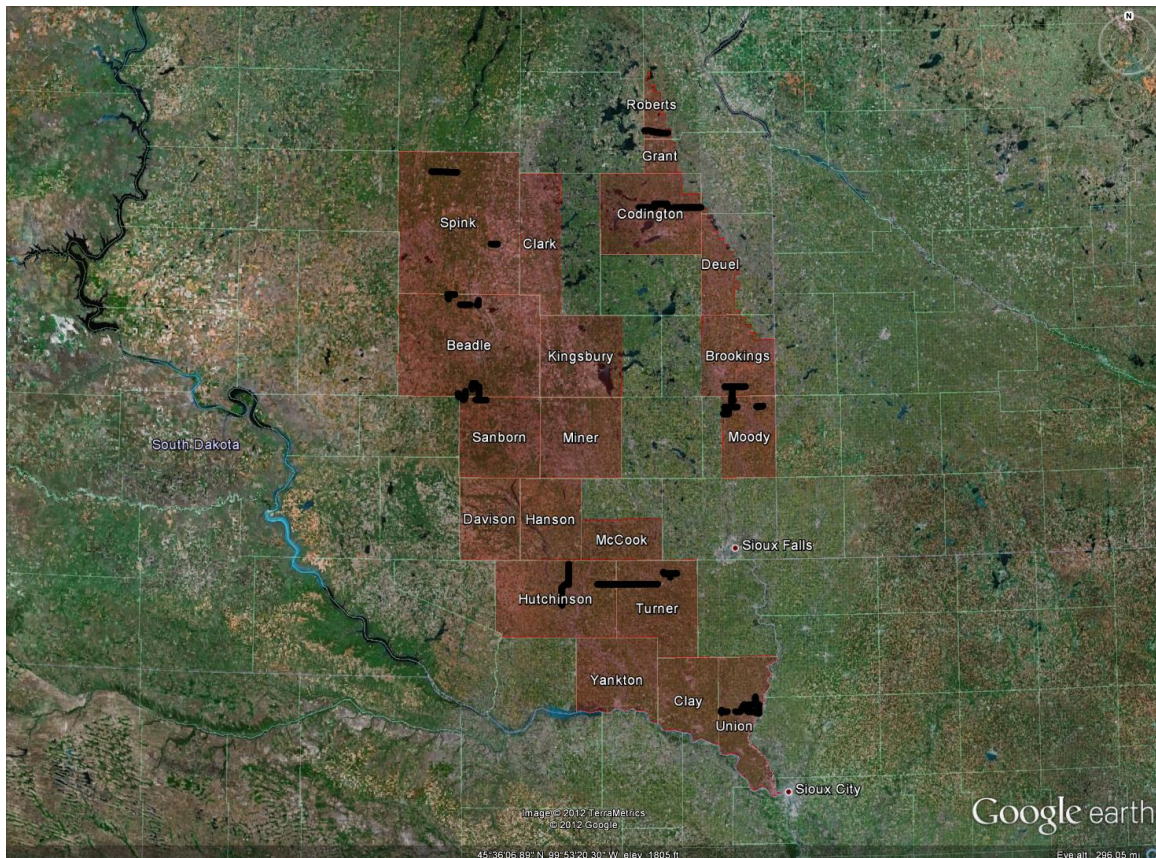
As a pro-active measure, in lieu of delivering the project beyond the required cut-off date of August 31st (Project completed October 31st), GeoDigital is providing one year subscription of data web-hosting and viewing software at no charge to the State of South Dakota.

8. Conclusion

Overall the LiDAR data products submitted to the State of South Dakota meet or exceed both the absolute and relative accuracy requirements as well as technical requirements set out in the Project Management Plan for this project. The quality control requirements of GeoDigital International *I-PROVE* program were adhered to throughout the project cycle to ensure product quality.

Appendix A GPS Validation

Fundamental Kinematic Validation layout



Fundamental kinematic Vertical Accuracy Summary

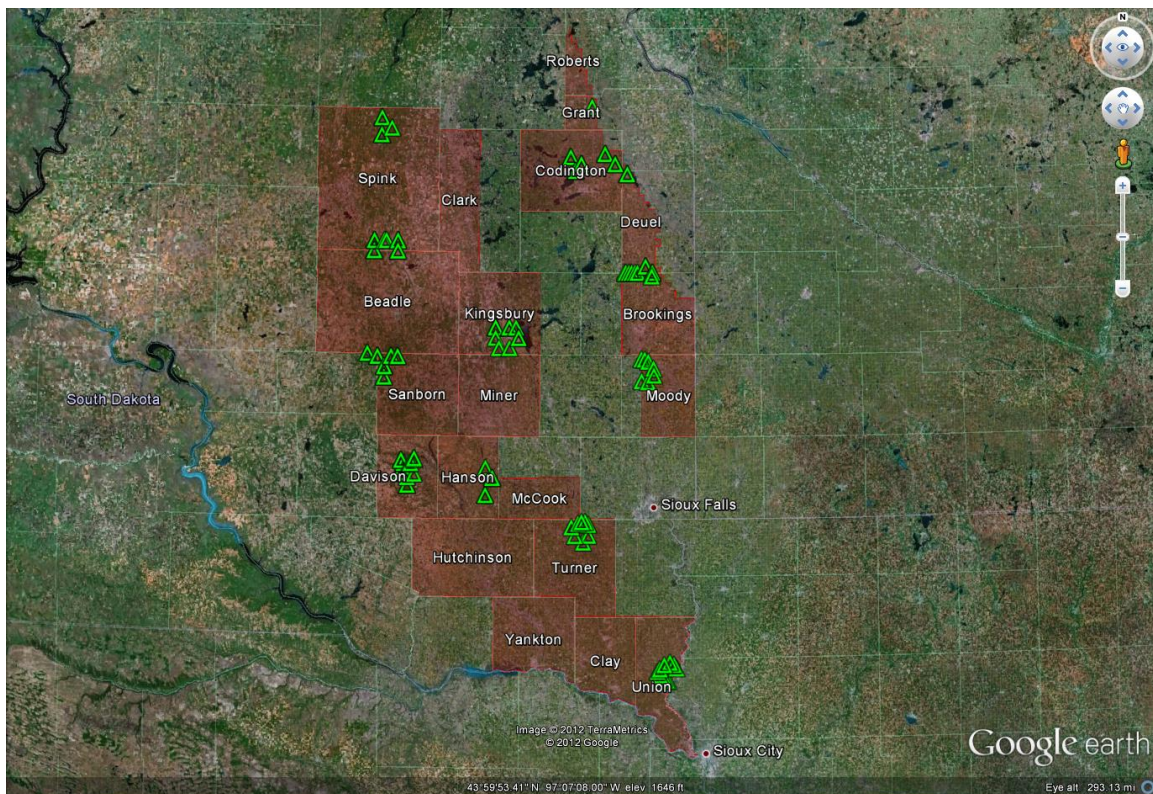
Ground Kinematic Fundamental

Sample Size	20239	Points	Std. Dev.	0.003	meters
sum	43.934	meters	Skew	0.301	meters
average	0.000	meters	Min	-0.237	meters
RMSE	0.047	meters	Max	0.186	meters
NSSDA	0.091	meters	Range	0.423	meters



Kinematic_Ground_Fundamental

Fundamental and Supplemental Static Point Layout



Fundamental and Supplemental Static Vertical Accuracy Summaries

Ground Static Fundamental

Sample Size	17	Points	St. Dev.	0.006	meters
sum	0.073	meters	Skew	0.677	meters
average	-0.032	meters	Min	-0.148	meters
RMSE	0.065	meters	Max	0.122	meters
NSSDA	0.128	meters	Range	0.270	meters



Static_Ground_Fundamental

Long Grass Static Supplemental

Sample Size	42	Points	St. Dev.	0.006	meters
sum	0.200	meters	Skew	0.052	meters
average	0.016	meters	Min	-0.132	meters
RMSE	0.069	meters	Max	0.145	meters
NSSDA	0.135	meters	Range	0.277	meters



Long_Grass_Supplemental

Short Grass Static Supplemental

Sample Size	54	Points	St. Dev.	0.005	meters
sum	0.278	meters	Skew	0.242	meters
average	0.001	meters	Min	-0.146	meters
RMSE	0.072	meters	Max	0.143	meters
NSSDA	0.141	meters	Range	0.289	meters



Short_Grass_Supplemental

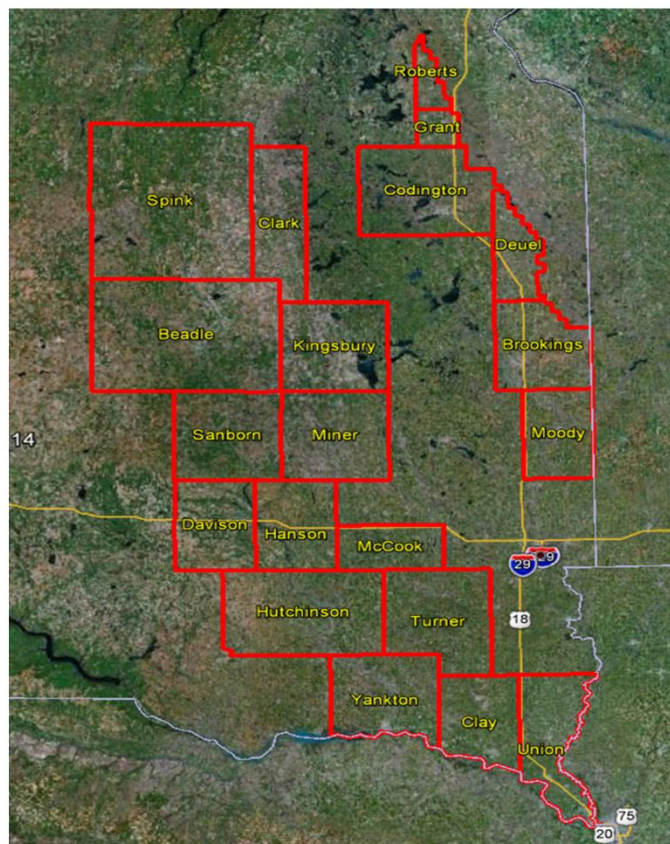


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Appendix B Geodetic Control Survey Report

Geodetic Control Report
South Dakota LiDAR
368SSD12-1





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Introduction

This report describes the GPS network adjustment performed to refine the positioning of airborne acquisition data (LiDAR) by GeoDigital International. The project is "South Dakota LiDAR" which included the Aerial survey of 20 counties in Eastern South Dakota.

The survey was conducted throughout the aerial acquisition during the months of March, April and May 2012. This report will present the steps followed to establish the GPS Network and adjustments performed.

GPS Network Survey – Personnel

GeoDigital Acquisition Crew	
Manager of Aerial Operations:	Craig Robertson
Ground Surveyor(s):	Scott Taylor; Carson Adam; Gary Tao; William Kowalsky, Kevin Morgan

GPS Network Survey - Equipment and Configuration

Receiver Model(s):	Sokkia GSR 2600, Novatel DL4
Number of GPS Receivers Used:	8
Antenna Model(s):	Sokkia SK600, Novatel GPS702
Survey Method:	Static Occupation (Long Term, >~4h)
Source of GPS Control:	NGS – National Geodetic survey
Horizontal Datum:	NAD83
Vertical Datum:	NAVD88
Geoid/Ellipsoid:	Geoid 09
Units:	Meters
NGS Monuments Used:	QQ0640, AC7987, PR1071, PR1027, AC7894, AC8003, OQ1162, AC7935, AC7901, AC7967
Established Points:	368SSD-01, 368SSD-02, 368SSD-03, 368SSD-04, 368SSD-05, 368SSD-06
GPS Control Network Software:	GrafNet (by Waypoint)

Requirements for LIDAR Control Points

Final control used for flight data processing should:

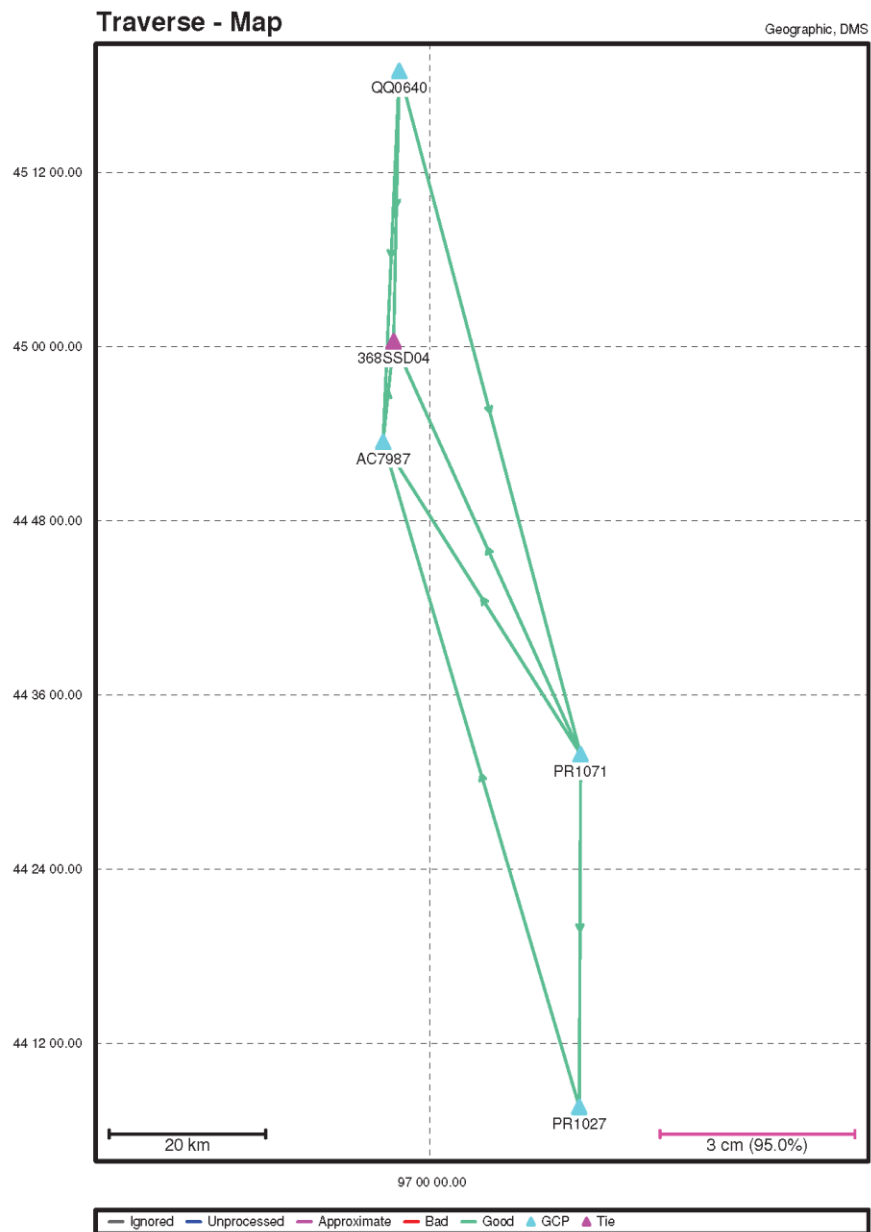
1. Be tied to geodetic control stations.
 - a. Geodetic control stations should be first order or better (unless otherwise specified by client). Preference shall be given to nationally maintained control points before provincial/state level better (unless otherwise specified by client).
 - b. All final flight & ground truthing control (published and/or new) should be tied to these geodetic points by two or more occupations (prove or disprove HI errors).
 - c. All new points used in final flight & ground truthing control require a tie to two AGREEING 3-D geodetic control stations (alternatively any combination of horizontal and vertical control such that both are represented twice). If disagreement is found (i.e. exceeding the tolerance required to meet project specifications), sufficient additional control points must be included in the survey to clearly identify the erroneous monument.
 - d. Final adjusted coordinates of published geodetic control stations should agree to $\pm 1/3^{\text{rd}}$ the required RMSE of the project or better. In cases where this is not achieved, additional control will be required to establish the error in the geodetic control point(s). When insufficient control can be found to agree to this standard, the issue must be taken to Operations Manager and the client.
2. Geodetic control stations may be used as final control for data processing if they meet the standards described in point 1d. In this case, the published coordinates shall be used unless special circumstances dictate otherwise.
3. Where projects use multiple control points for flight data processing, in addition to meeting the requirements of point 1, the flight control points must also be shown to tie to each other within the same specification (1d).

Typical collection parameters are defined as 6 satellites, PDOP of less than 4 and low geomagnetic activity. Under these conditions, the formula of 20 minutes plus 3 minutes per baseline kilometre shall be set as the minimum for each observation. Additional time shall be observed where the collection requirements cannot be met and/or obstructions are present.

Fully Constrained Network East

Project: 368SSD12-1 Fully Constrained Network East

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File: 368SSD12-1 Fully Constrained Network East.net

GrafNet v7.80.2517

```
*****
* NETWORK - WEIGHTED GPS NETWORK ADJUSTMENT          *
*                                                       *
* (c) Copyright NovAtel Inc., (2007)                  *
*                                                       *
* Version: 7.80.2517                                    *
*                                                       *
* FILE: C:\Projects\368 SSD 12\2_Operations\4_Control\Grafnet Project\368S
SD12-1 Fully Constrained Network East.net
*****
```

DATE(m/d/y): Thur. 4/19/12 TIME: 18:25:26

DATUM: 'NAD83_CORS96'
GRID: UTM, Zone 14
SCALE_FACTOR: 25.8242
CONFIDENCE LEVEL: 95.00 % (Scale factor is 2.4479)

INPUT CONTROL/CHECK POINTS

STA_ID	TYPE	-- LATITUDE --	-- LONGITUDE --	ELLHGT --	HZ-SD	V-SD
AC7987	GCP-3D	44 53 25.34836	-97 04 33.94998	502.205	0.00500	0.00500
PR1027	GCP-3D	44 07 35.76383	-96 45 31.27516	487.210	0.00500	0.00500
PR1071	GCP-3D	44 31 53.59709	-96 45 23.46307	509.188	0.01000	0.01000
QQ0640	GCP-3D	45 18 59.38654	-97 02 59.00413	589.670	0.00500	0.00500

INPUT VECTORS

SESSION NAME	VECTOR(m)	----- Covariance (m) [unscaled] -----
	DX/DY/DZ	standard deviations in brackets
AC7987 to 368SSD04 (1)	2459.3545 8797.7098 9095.8140	3.8176e-007 {0.0006} 1.8053e-007 {0.0014} -1.3503e-006 {0.0014}
PR1027 to AC7987 (1)	-17892.5779 62096.9176 60541.0418	6.4054e-006 {0.0025} -2.1929e-006 {0.0023} 5.1447e-007 {0.0018}
PR1071 to 368SSD04 (1)	-19303.4895 39703.0577 37430.3429	1.0574e-005 {0.0033} 1.2378e-006 {0.0015} -6.2940e-007 {0.0014}
PR1071 to AC7987 (1)	-21762.8325 30905.3587 28334.5442	4.2238e-006 {0.0021} -1.7928e-006 {0.0018} 5.2137e-007 {0.0014}
PR1071 to AC7987 (2)	-21762.8402 30905.3536 28334.5268	9.0066e-006 {0.0030} 1.4056e-006 {0.0015} -6.3817e-007 {0.0013}
PR1071 to PR1027 (1)	-3870.2477 -31191.5560 -32206.5007	4.0552e-006 {0.0020} -1.2266e-006 {0.0018} 2.4981e-007 {0.0014}



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Report

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File: 368SSD12-1 Fully Constrained Network East.net

GrafNet v7.80.2517

```
QQ0640 to AC7987 (1)  -6177.7761  8.7454e-006 {0.0030}
                      -32978.2130  1.2295e-006 2.5078e-006 {0.0016}
                      -33490.3724 -4.8355e-007 -1.3444e-006 1.7247e-006 {0.0013}

QQ0640 to 368SSD04 (1) -3718.4138  1.3211e-006 {0.0011}
                      -24180.5113  6.1789e-007 7.7029e-006 {0.0028}
                      -24394.5515 -4.6979e-007 -5.6812e-006 9.2290e-006 {0.0030}

QQ0640 to PR1071 (1)  15585.0678  8.7071e-006 {0.0030}
                      -63883.5645  1.8860e-006 2.3852e-006 {0.0015}
                      -61824.9015 -5.5137e-007 -1.3476e-006 1.7609e-006 {0.0013}
```

OUTPUT VECTOR RESIDUALS (East, North, Height - Local Level)

SESSION NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)	- PPM -	DIST - (km)	STD - (m)
AC7987 to 368SSD04 (1)	-0.0009	-0.0039	-0.0001	0.309	12.9	0.0105
PR1027 to AC7987 (1)	0.0180	-0.0094	0.0194	0.317	88.6	0.0195
PR1071 to 368SSD04 (1)	0.0165	0.0059	-0.0020	0.305	57.9	0.0194
PR1071 to AC7987 (1)	0.0074	-0.0096	-0.0041	0.272	47.2	0.0157
PR1071 to AC7987 (2)	0.0144	0.0069	0.0039	0.349	47.2	0.0184
PR1071 to PR1027 (1)	-0.0171	-0.0008	-0.0187	0.564	45.0	0.0154
QQ0640 to AC7987 (1)	0.0093	0.0039	0.0047	0.235	47.4	0.0183
QQ0640 to 368SSD04 (1)	-0.0004	0.0002	-0.0053	0.155	34.5	0.0217
QQ0640 to PR1071 (1)	-0.0086	-0.0032	0.0042	0.112	90.3	0.0182
RMS	0.0121	0.0058	0.0096			

\$ - This session is flagged as a 3-sigma outlier

CONTROL POINT RESIDUALS (ADJUSTMENT MADE)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
AC7987	-0.0051	-0.0012	-0.0043
PR1027	0.0046	0.0001	0.0063
PR1071	0.0009	-0.0049	-0.0178
QQ0640	0.0002	0.0024	0.0025
RMS	0.0035	0.0028	0.0098

OUTPUT STATION COORDINATES (LAT/LONG/HT)

STA_ID	-- LATITUDE --	-- LONGITUDE --	- ELLHGT -	ORTHOHGT
368SSD04	45 00 20.58849	-97 03 31.99780	534.6677	559.8598
AC7987	44 53 25.34832	-97 04 33.95021	502.2003	527.2942
PR1027	44 07 35.76383	-96 45 31.27495	487.2161	513.0131
PR1071	44 31 53.59693	-96 45 23.46303	509.1699	534.2054
QQ0640	45 18 59.38662	-97 02 59.00412	589.6721	614.9944



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File: 368SSD12-1 Fully Constrained Network East.net

GrafNet v7.80.2517

OUTPUT STATION COORDINATES (GRID)

STA_ID	- EASTING - (m)	- NORTHING - (m)	- ELLHGT - (m)	- ORTHOHT (m)
368SSD04	652974.1137	4985418.5658	534.6677	559.8598
AC7987	651921.9851	4972572.9879	502.2003	527.2942
PR1027	679314.1622	4888376.8313	487.2161	513.0131
PR1071	678256.4018	4933362.3296	509.1699	534.2054
QQ0640	652862.7551	5019960.2246	589.6721	614.9944

OUTPUT VARIANCE/COVARIANCE

STA_ID	SE/SN/SUP (95.00 %) (m)	----- (not scaled by confidence level) (ECEF, XYZ cartesian) 2	CX matrix (m)-----
368SSD04	0.0104 0.0099 0.0172	1.8522e-005 2.2659e-006 -6.5868e-007	3.4037e-005 3.1696e-005
AC7987	0.0092 0.0078 0.0095	1.4141e-005 -2.1457e-007 -9.4707e-008	1.3206e-005 -2.4233e-006 1.2048e-005
PR1027	0.0107 0.0088 0.0106	1.8993e-005 -1.3578e-006 -1.5881e-007	1.6950e-005 -3.0277e-006 1.5001e-005
PR1071	0.0127 0.0082 0.0115	2.6741e-005 -4.2084e-007 -1.9043e-007	1.7814e-005 -5.3523e-006 1.5489e-005
QQ0640	0.0098 0.0083 0.0102	1.6313e-005 7.3037e-007 -1.5947e-007	1.4915e-005 -2.8349e-006 1.3801e-005

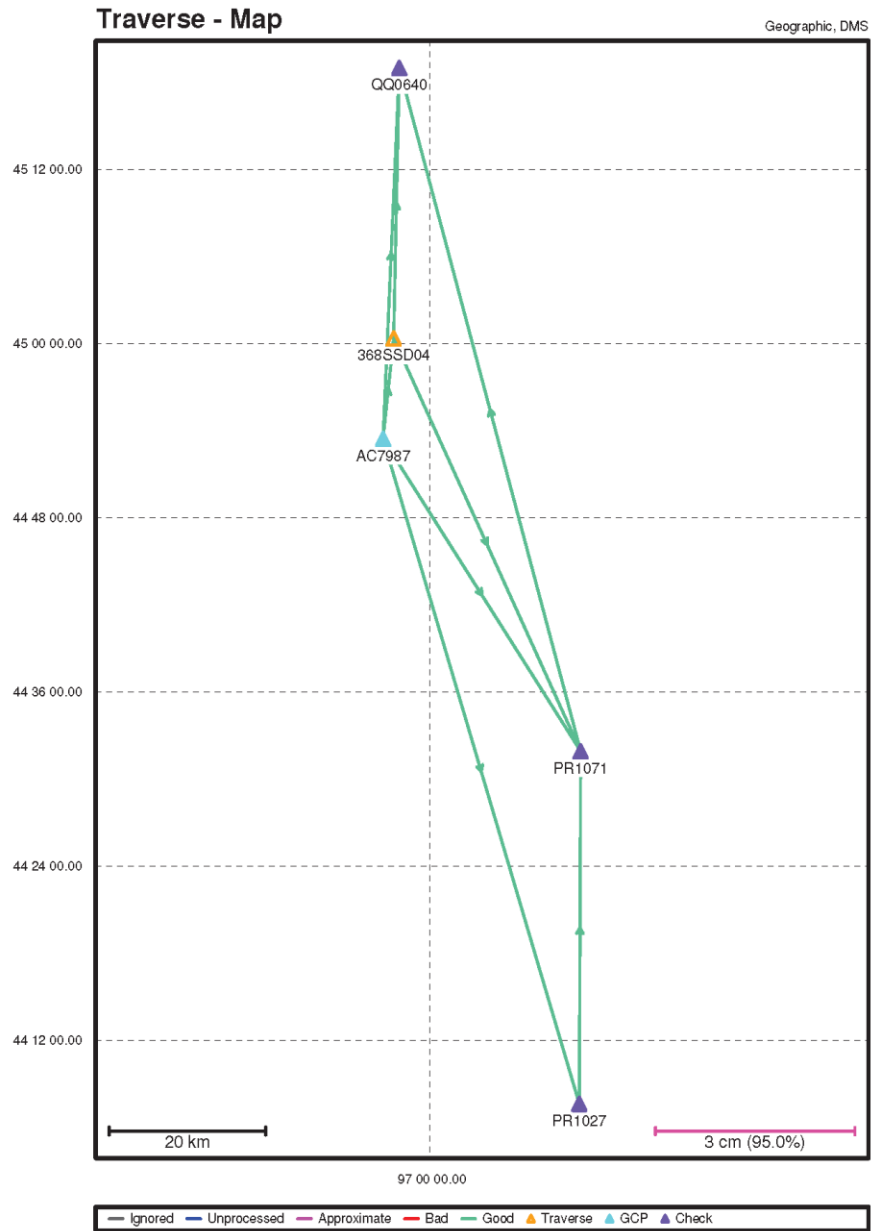
VARIANCE FACTOR = 1.5995

Note: Values < 1.0 indicate statistics are pessimistic, while
values > 1.0 indicate optimistic statistics. Entering this
value as the network adjustment scale factor will bring
variance factor to one.

Un-Constrained Network East

Project: 368SSD12-1 Uncon Network East

GrafNet v7.80.2517





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Error! Reference source not found.

File: 368SSD12-1 Uncon Network East.net

GrafNet v7.80.2517

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*****
* NETWORK - WEIGHTED GPS NETWORK ADJUSTMENT          *
*                                                       *
* (c) Copyright NovAtel Inc., (2007)                  *
*                                                       *
* Version: 7.80.2517                                    *
*                                                       *
* FILE: C:\Projects\368 SSD 12\2_Operations\4_Control\Grafnet Project\368S
SD12-1 Uncon Network East.net
*****
```

DATE(m/d/y): Wed. 4/25/12 TIME: 7:23:04

DATUM: 'NAD83_CORS96'
GRID: UTM, Zone 14
SCALE_FACTOR: 17.1100
CONFIDENCE LEVEL: 95.00 % (Scale factor is 2.4479)

INPUT CONTROL/CHECK POINTS

STA_ID	TYPE	-- LATITUDE --	-- LONGITUDE --	ELLHGT --	HZ-SD	V-SD
AC7987	GCP-3D	44 53 25.34836	-97 04 33.94998	502.205	0.00500	0.00500
PR1027	CHK-3D	44 07 35.76383	-96 45 31.27516	487.210		
PR1071	CHK-3D	44 31 53.59709	-96 45 23.46307	509.188		
QQ0640	CHK-3D	45 18 59.38654	-97 02 59.00413	589.670		

INPUT VECTORS

SESSION NAME	VECTOR(m)	----- Covariance (m) [unscaled] -----
	DX/DY/DZ	standard deviations in brackets
368SSD04 to PR1071 (1)	19303.4904	1.0624e-005 (0.0033)
	-39703.0575	1.0920e-006 2.0761e-006 (0.0014)
	-37430.3438	-5.0404e-007 -1.2992e-006 1.8344e-006 (0.0014)
368SSD04 to QQ0640 (1)	3718.4136	1.3205e-006 (0.0011)
	24180.5098	6.1879e-007 7.7135e-006 (0.0028)
	24394.5530	-4.7061e-007 -5.6801e-006 9.2157e-006 (0.0030)
AC7987 to 368SSD04 (1)	2459.3545	3.8176e-007 (0.0006)
	8797.7098	1.8053e-007 2.0322e-006 (0.0014)
	9095.8140	4.0413e-009 -1.3503e-006 1.8462e-006 (0.0014)
AC7987 to PR1027 (1)	17892.5778	6.3841e-006 (0.0025)
	-62096.9175	-2.1925e-006 5.1344e-006 (0.0023)
	-60541.0426	5.2019e-007 -2.6195e-006 3.2432e-006 (0.0018)
AC7987 to PR1071 (1)	21762.8325	4.2145e-006 (0.0021)
	-30905.3587	-1.7917e-006 3.4165e-006 (0.0018)
	-28334.5451	5.2332e-007 -1.6841e-006 1.8808e-006 (0.0014)
AC7987 to PR1071 (2)	21762.8414	8.7866e-006 (0.0030)
	-30905.3536	1.1127e-006 2.2634e-006 (0.0015)
	-28334.5275	-4.4317e-007 -1.2545e-006 1.6526e-006 (0.0013)



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Report

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File: 368SSD12-1 Uncon Network East.net

GrafNet v7.80.2517

```
AC7987 to QQ0640 (1)  6177.7761  8.7544e-006 {0.0030}
                      32978.2130  1.2288e-006 2.5111e-006 {0.0016}
                      33490.3714 -4.8353e-007 -1.3435e-006 1.7224e-006 {0.0013}

PR1027 to PR1071 (1)  3870.2472  4.0908e-006 {0.0020}
                      31191.5571 -1.1639e-006 3.1693e-006 {0.0018}
                      32206.4980  1.3003e-007 -1.5246e-006 1.9292e-006 {0.0014}

PR1071 to QQ0640 (1) -15585.0678  8.7205e-006 {0.0030}
                      63883.5644  1.8898e-006 2.3935e-006 {0.0015}
                      61824.9005 -5.5236e-007 -1.3478e-006 1.7571e-006 {0.0013}
```

OUTPUT VECTOR RESIDUALS (East, North, Height - Local Level)

SESSION NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)	- PPM -	DIST - (km)	STD - (m)
368SSD04 to PR1071 (1)	-0.0132	-0.0057	0.0017	0.251	57.9	0.0158
368SSD04 to QQ0640 (1)	0.0010	-0.0007	0.0057	0.169	34.5	0.0177
AC7987 to 368SSD04 (1)	-0.0006	-0.0041	0.0008	0.328	12.9	0.0085
AC7987 to PR1027 (1)	0.0027	0.0069	0.0018	0.086	88.6	0.0159
AC7987 to PR1071 (1)	-0.0030	0.0098	0.0046	0.238	47.2	0.0128
AC7987 to PR1071 (2)	-0.0112	-0.0070	-0.0035	0.288	47.2	0.0147
AC7987 to QQ0640 (1)	-0.0084	-0.0038	-0.0006	0.195	47.4	0.0149
PR1027 to PR1071 (1)	0.0016	0.0045	0.0005	0.107	45.0	0.0125
PR1071 to QQ0640 (1)	0.0050	0.0037	0.0000	0.069	90.3	0.0148
RMS	0.0068	0.0057	0.0028			

\$ - This session is flagged as a 3-sigma outlier

CHECK POINT RESIDUALS (East, North, Height - Local Level)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
PR1027	0.0303	-0.0016	0.0314
PR1071	0.0105	-0.0041	-0.0136
QQ0640	0.0062	0.0030	0.0103
RMS	0.0189	0.0031	0.0206

CONTROL POINT RESIDUALS (ADJUSTMENT MADE)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
AC7987	0.0000	0.0000	0.0000
RMS	0.0000	0.0000	0.0000

OUTPUT STATION COORDINATES (LAT/LONG/HT)



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

File: 368SSD12-1 Uncon Network East.net

GrafNet v7.80.2517

STA_ID	--	LATITUDE	--	LONGITUDE	--	ELLHGT	--	ORTHOHGT
368SSD04	45	00	20.58853	-97	03	31.99756	534.6730	559.8652
AC7987	44	53	25.34836	-97	04	33.94998	502.2047	527.2985
PR1027	44	07	35.76378	-96	45	31.27380	487.2411	513.0382
PR1071	44	31	53.59696	-96	45	23.46260	509.1741	534.2096
QQ0640	45	18	59.38664	-97	02	59.00385	589.6799	615.0022

OUTPUT STATION COORDINATES (GRID)

STA_ID	-	EASTING	-	NORTHING	-	ELLHGT	-	ORTHOHGT
		(m)		(m)		(m)		(m)
368SSD04	652974.1191	4985418.5669	534.6730	559.8652				
AC7987	651921.9901	4972572.9893	502.2047	527.2985				
PR1027	679314.1879	4888376.8303	487.2411	513.0382				
PR1071	678256.4113	4933362.3307	509.1741	534.2096				
QQ0640	652862.7611	5019960.2253	589.6799	615.0022				

OUTPUT VARIANCE/COVARIANCE

STA_ID	SE/SN/SUP	-----	CX matrix (m)	-----
	(95.00 %)		(not scaled by confidence level)	
	(m)		(ECEF, XYZ cartesian)	
368SSD04	0.0135	3.0840e-005		
	0.0136	1.7843e-006	4.3589e-005	
	0.0181	-6.3904e-008	-1.1939e-005	4.1586e-005
AC7987	0.0122	2.5000e-005		
	0.0122	-1.2540e-021	2.5000e-005	
	0.0122	-8.7484e-022	-4.9232e-020	2.5000e-005
PR1027	0.0218	7.5951e-005		
	0.0146	-1.3790e-005	6.2884e-005	
	0.0210	2.4515e-006	-1.9107e-005	4.9153e-005
PR1071	0.0169	4.7800e-005		
	0.0131	-9.2057e-007	3.6633e-005	
	0.0158	2.7641e-008	-6.6656e-006	3.3874e-005
QQ0640	0.0164	4.6123e-005		
	0.0138	3.9992e-006	4.5663e-005	
	0.0182	-1.5349e-006	-1.1754e-005	4.0764e-005

VARIANCE FACTOR = 1.0000

Note: Values < 1.0 indicate statistics are pessimistic, while
values > 1.0 indicate optimistic statistics. Entering this
value as the network adjustment scale factor will bring
variance factor to one.



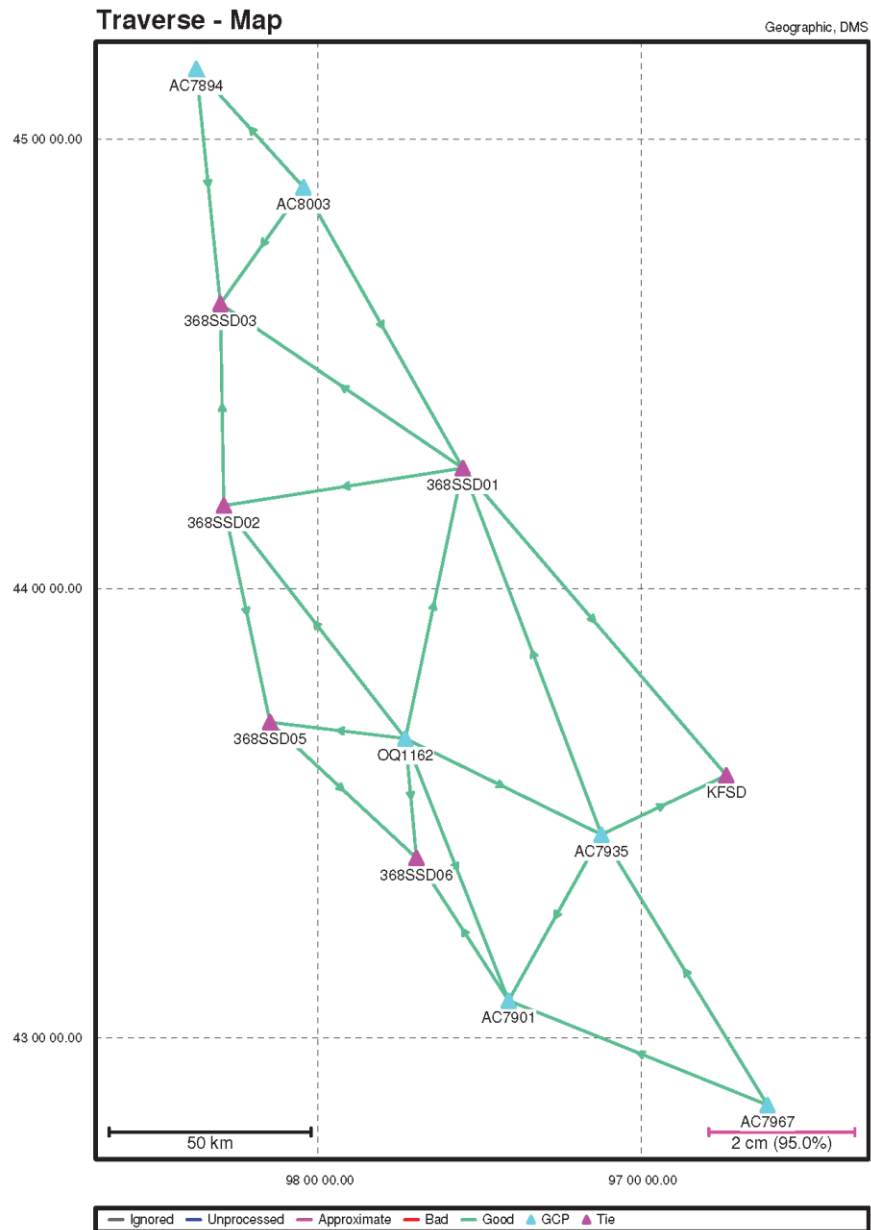
Error! Reference source not found.South Dakota LiDAR Project
Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

Fully Constrained Network West

Project: 368SSD12-1 FullyCon Network West

GrafNet v7.80.2517





Error! Reference source not found.South Dakota LiDAR Project
Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

File: 368SSD12-1 FullyCon Network West.net

GrafNet v7.80.2517

```
*****
* NETWORK - WEIGHTED GPS NETWORK ADJUSTMENT          *
*                                                       *
* (c) Copyright NovAtel Inc., (2007)                  *
*                                                       *
* Version: 7.80.2517                                    *
*                                                       *
* FILE: C:\Projects\368 SSD 12\2_Operations\4_Control\Grafnet Project\368S
SD12-1 FullyCon Network West.net
*****
```

DATE(m/d/y): Tue. 5/01/12 TIME: 19:35:05

DATUM: 'NAD83_CORS96'
GRID: UTM, Zone 14
SCALE_FACTOR: 244.1785
CONFIDENCE LEVEL: 95.00 % (Scale factor is 2.4479)

INPUT CONTROL/CHECK POINTS

STA_ID	TYPE	-- LATITUDE --	-- LONGITUDE --	ELLHGT --	HZ-SD	V-SD
AC7894	GCP-3D	45 09 22.94132	-98 22 35.00326	371.693	0.00500	0.00500
AC7901	GCP-3D	43 04 57.50473	-97 24 35.58390	381.786	0.00500	0.00500
AC7935	GCP-3D	43 27 08.77685	-97 07 20.90762	387.429	0.00500	0.00500
AC7967	GCP-3D	42 51 02.63636	-96 36 31.55856	328.943	0.00500	0.00500
AC8003	GCP-3D	44 53 33.72035	-98 02 38.93491	395.903	0.00500	0.00500
OQ1162	GCP-3D	43 39 58.08703	-97 43 45.64149	389.114	0.00500	0.00500

INPUT VECTORS

SESSION NAME	VECTOR(m)	----- Covariance (m) [unscaled] -----
	DX/DY/DZ	standard deviations in brackets
368SSD01 to 368SSD02 (1)	-59404.0222 1.5449e-007 (0.0004)	
	1806.1346 8.8001e-008 6.4935e-007 (0.0008)	
	-6714.3232 -6.2868e-008 -4.0520e-007 6.4251e-007 (0.0008)	
368SSD01 to 368SSD03 (1)	-55176.9721 1.6071e-006 (0.0013)	
	36448.4533 1.1020e-006 7.5520e-006 (0.0027)	
	28895.2547 -5.5694e-007 -4.6270e-006 7.1022e-006 (0.0027)	
368SSD01 to 368SSD03 (2)	-55176.9450 5.5220e-007 (0.0007)	
	36448.4357 3.4791e-007 2.2684e-006 (0.0015)	
	28895.2758 -1.9507e-007 -1.4423e-006 2.2321e-006 (0.0015)	
368SSD01 to KFSD (1)	58459.8287 7.5751e-007 (0.0009)	
	-60394.3072 5.1502e-007 3.1285e-006 (0.0018)	
	-54765.5503 -3.1807e-007 -1.8908e-006 3.1802e-006 (0.0018)	
368SSD01 to KFSD (2)	58459.8116 1.1091e-006 (0.0011)	
	-60394.2935 6.0695e-007 4.4925e-006 (0.0021)	
	-54765.5469 -3.7903e-007 -2.8110e-006 4.0636e-006 (0.0020)	
368SSD02 to 368SSD05 (1)	6100.4975 3.0493e-006 (0.0017)	



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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File: 368SSD12-1 FullyCon Network West.net

GrafNet v7.80.2517

```
-38464.7764 6.2840e-008 8.9528e-006 {0.0030}
-38577.2101 6.5957e-007 -5.2845e-006 8.0861e-006 {0.0028}

368SSD02 to 368SSD03 {1} 4227.0500 1.0748e-006 {0.0010}
34642.3136 7.6939e-007 5.0475e-006 {0.0022}
35609.5930 -3.9066e-007 -3.0632e-006 4.6846e-006 {0.0022}

368SSD05 to 368SSD06 {1} 33055.8930 8.7674e-007 {0.0009}
-27935.9343 5.4844e-007 3.5477e-006 {0.0019}
-24332.3330 -2.7438e-007 -2.1321e-006 3.0313e-006 {0.0017}

368SSD05 to 368SSD06 {2} 33055.8897 7.6013e-007 {0.0009}
-27935.9924 4.7921e-007 2.9889e-006 {0.0017}
-24332.2736 -3.1181e-007 -1.8286e-006 2.6603e-006 {0.0016}

AC7894 to 368SSD03 {1} -105.8015 9.2146e-007 {0.0010}
-41472.2021 6.2201e-007 3.5241e-006 {0.0019}
-41202.0762 -3.7912e-007 -2.1524e-006 3.1260e-006 {0.0018}

AC7901 to 368SSD06 {1} -19769.8265 3.6792e-007 {0.0006}
27000.0240 2.1940e-007 1.5441e-006 {0.0012}
25689.9301 -1.2694e-007 -9.4213e-007 1.3268e-006 {0.0012}

AC7935 to 368SSD01 {2} -26230.8968 9.4249e-007 {0.0010}
66615.7808 5.4532e-007 4.0108e-006 {0.0020}
65392.3564 -3.0407e-007 -2.4134e-006 3.4051e-006 {0.0018}

AC7935 to AC7901 {1} -26708.8230 1.0298e-006 {0.0010}
-24979.0239 4.6937e-007 4.4895e-006 {0.0021}
-29921.2650 -2.5220e-007 -2.7117e-006 3.7418e-006 {0.0019}

AC7935 to AC7901 {2} -26708.8524 5.0621e-007 {0.0007}
-24978.9948 2.9628e-007 2.0145e-006 {0.0014}
-29921.2559 -1.6910e-007 -1.2590e-006 2.1665e-006 {0.0015}

AC7935 to KFSD {1} 32228.9294 1.5181e-006 {0.0012}
6221.4719 2.1064e-006 7.8259e-006 {0.0028}
10626.8105 -3.9779e-007 -3.7392e-006 8.0891e-006 {0.0028}

AC7935 to KFSD {2} 32228.9155 1.7148e-007 {0.0004}
6221.4895 1.0853e-007 7.0832e-007 {0.0008}
10626.8032 -6.6471e-008 -4.2628e-007 6.8569e-007 {0.0008}

AC7967 to AC7901 {1} -62735.5501 1.3296e-006 {0.0012}
25366.5766 8.7388e-007 5.6533e-006 {0.0024}
18889.2401 -2.6207e-007 -3.3480e-006 5.6730e-006 {0.0024}

AC7967 to AC7935 {1} -36026.7496 4.6267e-006 {0.0022}
50345.6714 5.5985e-006 1.9745e-005 {0.0044}
48810.4531 -3.2576e-006 -6.8433e-006 1.1694e-005 {0.0034}

AC8003 to 368SSD01 {1} 32115.9111 6.4122e-007 {0.0008}
-53646.5552 3.9960e-007 2.6682e-006 {0.0016}
-49402.1176 -2.2415e-007 -1.6926e-006 2.6500e-006 {0.0016}

AC8003 to 368SSD03 {1} -23061.0345 4.0751e-007 {0.0006}
-17198.1201 2.1207e-007 1.1549e-006 {0.0011}
-20506.8415 -1.1140e-007 -7.7527e-007 1.3777e-006 {0.0012}

AC8003 to AC7894 {1} -22955.2341 4.7067e-007 {0.0007}
24274.0739 2.2381e-007 2.3791e-006 {0.0015}
20695.2400 7.7597e-009 -1.5852e-006 2.1671e-006 {0.0015}

OQ1162 to 368SSD05 {1} -33024.0500 4.6692e-007 {0.0007}
7395.9631 3.0788e-007 2.0456e-006 {0.0014}
2893.4541 -1.4639e-007 -1.2038e-006 1.6687e-006 {0.0013}
```



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GDI #:368_SSD12-1 **Error! Reference source not found.**
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File: 368SSD12-1 FullyCon Network West.net

GrafNet v7.80.2517

```
Q01162 to 368SSD01 (1) 20279.5913 2.5901e-007 {0.0005}
                        44054.7204 1.3596e-007 1.1980e-006 {0.0011}
                        48184.8290 -1.1033e-007 -7.2794e-007 1.1073e-006 {0.0011}

Q01162 to 368SSD02 (1) -39124.5774 4.4870e-006 {0.0021}
                        45860.7063 4.1318e-006 1.4019e-005 {0.0037}
                        41470.6679 -1.9036e-006 -5.2231e-006 1.3565e-005 {0.0037}

Q01162 to 368SSD02 (2) -39124.4305 2.8147e-007 {0.0005}
                        45860.8553 1.4926e-007 1.3012e-006 {0.0011}
                        41470.5066 -1.2256e-007 -7.8962e-007 1.1977e-006 {0.0011}

Q01162 to 368SSD05 (2) -33024.0533 5.4106e-007 {0.0007}
                        7395.9544 3.2084e-007 2.1718e-006 {0.0015}
                        2893.4522 -2.0773e-007 -1.3340e-006 1.9151e-006 {0.0014}

Q01162 to 368SSD06 (1) 31.8450 2.1360e-006 {0.0015}
                        -20539.9705 3.4716e-007 6.8590e-006 {0.0026}
                        -21438.8817 -5.2086e-007 -4.5605e-006 5.3030e-006 {0.0023}

Q01162 to 368SSD06 (2) 31.8407 4.3296e-005 {0.0066}
                        -20540.0378 -2.7238e-005 8.8812e-005 {0.0094}
                        -21438.8287 1.6631e-005 -3.1734e-005 3.1471e-005 {0.0056}

Q01162 to AC7901 (1) 19801.6754 9.9258e-007 {0.0010}
                        -47540.1009 6.8690e-007 4.3885e-006 {0.0021}
                        -47128.7716 -3.4204e-007 -2.5478e-006 3.5435e-006 {0.0019}

Q01162 to AC7901 (2) 19801.6625 8.4101e-007 {0.0009}
                        -47540.0626 5.0019e-007 3.4412e-006 {0.0019}
                        -47128.7524 -2.9899e-007 -2.1119e-006 2.9361e-006 {0.0017}

Q01162 to AC7935 (1) 46510.4902 1.1175e-006 {0.0011}
                        -22561.0643 9.6176e-007 5.2731e-006 {0.0023}
                        -17207.5239 -7.5991e-007 -2.8553e-006 5.3421e-006 {0.0023}

Q01162 to AC7935 (2) 46510.4871 8.2980e-007 {0.0009}
                        -22561.0606 4.9992e-007 3.5976e-006 {0.0019}
                        -17207.5266 -2.9948e-007 -2.2167e-006 3.1335e-006 {0.0018}

Q01162 to AC7935 (3) 46510.4981 3.9220e-006 {0.0020}
                        -22561.0640 7.5262e-008 5.1030e-006 {0.0023}
                        -17207.5230 -2.2677e-007 -1.8683e-006 2.3185e-006 {0.0015}
```

OUTPUT VECTOR RESIDUALS (East, North, Height - Local Level)

SESSION NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)	- PPM -	DIST - (km)	STD - (m)
368SSD01 to 368SSD02 (1)	-0.0032	0.0006	0.0089	0.159	59.8	0.0188
368SSD01 to 368SSD03 (1)	0.0248	0.0062	0.0415	0.676	72.2	0.0630
368SSD01 to 368SSD03 (2)	-0.0045	0.0007	0.0170	0.244	72.2	0.0351
368SSD01 to KFSD (1)	-0.0088	0.0066	-0.0193	0.221	100.3	0.0415
368SSD01 to KFSD (2)	0.0098	-0.0038	-0.0134	0.170	100.3	0.0486
368SSD02 to 368SSD05 (1)	-0.0893	0.0102	0.1599	3.346	54.8	0.0700
368SSD02 to 368SSD03 (1)	0.0275	0.0056	0.0253	0.758	49.9	0.0514
368SSD05 to 368SSD06 (1)	-0.0004	-0.0030	0.0689	1.390	49.7	0.0427
368SSD05 to 368SSD06 (2)	-0.0052	-0.0061	-0.0140	0.325	49.7	0.0396
AC7894 to 368SSD03 (1)	-0.0093	-0.0047	-0.0175	0.348	58.5	0.0430
AC7901 to 368SSD06 (1)	0.0031	0.0068	-0.0358	0.866	42.2	0.0281
AC7935 to 368SSD01 (2)	-0.0063	-0.0008	0.0159	0.176	97.0	0.0452
AC7935 to AC7901 (1)	-0.0108	0.0259	0.0093	0.625	47.3	0.0476
AC7935 to AC7901 (2)	0.0220	0.0020	0.0214	0.651	47.3	0.0338



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

File: 368SSD12-1 FullyCon Network West.net

GrafNet v7.80.2517

AC7935 to KFS	{1}	-0.0129	0.0040	-0.0080	0.455	34.5	0.0652
AC7935 to KFS	{2}	0.0030	-0.0016	0.0085	0.265	34.5	0.0196
AC7967 to AC7901	{1}	-0.0090	-0.0040	-0.0153	0.259	70.3	0.0556
AC7967 to AC7935	{1}	0.0325	-0.0382	0.0604	0.996	78.8	0.0938
AC8003 to 368SSD01	{1}	-0.0049	-0.0034	-0.0307	0.392	79.7	0.0381
AC8003 to 368SSD03	{1}	-0.0089	-0.0025	-0.0143	0.483	35.3	0.0268
AC8003 to AC7894	{1}	0.0003	0.0043	-0.0065	0.198	39.3	0.0350
QQ1162 to 368SSD05	{1}	0.0056	-0.0079	-0.0082	0.373	34.0	0.0320
QQ1162 to 368SSD01	{1}	-0.0010	0.0044	0.0271	0.402	68.4	0.0250
QQ1162 to 368SSD02	{1}	0.1202	0.0047	-0.1972	3.157	73.2	0.0885
QQ1162 to 368SSD02	{2}	-0.0045	0.0043	0.0358	0.496	73.2	0.0261
QQ1162 to 368SSD05	{2}	0.0076	-0.0003	-0.0134	0.455	34.0	0.0336
QQ1162 to 368SSD06	{1}	0.0030	-0.0096	0.0634	2.162	29.7	0.0591
QQ1162 to 368SSD06	{2}	-0.0017	-0.0017	-0.0219	0.741	29.7	0.1999
QQ1162 to AC7901	{1}	-0.0181	0.0265	-0.0047	0.464	69.8	0.0467
QQ1162 to AC7901	{2}	-0.0002	-0.0124	0.0085	0.215	69.8	0.0420
QQ1162 to AC7935	{1}	0.0026	0.0053	0.0062	0.157	54.5	0.0535
QQ1162 to AC7935	{2}	0.0062	0.0050	0.0104	0.240	54.5	0.0430
QQ1162 to AC7935	{3}	-0.0052	0.0038	0.0065	0.168	54.5	0.0526
RMS		0.0284	0.0106	0.0514			

\$ - This session is flagged as a 3-sigma outlier

CONTROL POINT RESIDUALS (ADJUSTMENT MADE)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
AC7894	-0.0012	-0.0010	-0.0002
AC7901	0.0000	-0.0016	-0.0024
AC7935	0.0010	0.0009	0.0009
AC7967	0.0008	-0.0004	0.0003
AC8003	-0.0036	0.0003	-0.0017
QQ1162	0.0030	0.0017	0.0031

RMS	0.0021	0.0011	0.0018

OUTPUT STATION COORDINATES (LAT/LONG/HT)

STA_ID	-- LATITUDE --	-- LONGITUDE --	- ELLHGT -	ORTHOHGT
368SSD01	44 16 04.38891	-97 33 06.78382	474.0593	499.3552
368SSD02	44 11 03.94262	-98 17 28.79747	375.7676	401.0253
368SSD03	44 37 58.96122	-98 18 05.66949	370.3693	394.8881
368SSD05	43 42 07.73595	-98 08 51.49130	388.6436	414.8141
368SSD06	43 24 00.35765	-97 41 41.48358	375.8463	402.0193
AC7894	45 09 22.94129	-98 22 35.00332	371.6924	396.1318
AC7901	43 04 57.50468	-97 24 35.58390	381.7834	407.5541
AC7935	43 27 08.77688	-97 07 20.90758	387.4296	413.6162
AC7967	42 51 02.63635	-96 36 31.55852	328.9431	354.5871
AC8003	44 53 33.72036	-98 02 38.93507	395.9010	420.3459
KFS	43 35 02.89664	-96 44 09.87836	406.7137	433.0136
QQ1162	43 39 58.08709	-97 43 45.64136	389.1169	415.1584

OUTPUT STATION COORDINATES (GRID)



Error! Reference source not found.South Dakota LiDAR Project
Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

File: 368SSD12-1 FullyCon Network West.net

GrafNet v7.80.2517

STA_ID	- EASTING - (m)	- NORTHING - (m)	- ELLHGT - (m)	ORTHOHGT (m)
368SSD01	615578.0569	4902646.6456	474.0593	499.3552
368SSD02	556640.5261	4892601.3829	375.7676	401.0253
368SSD03	555396.8317	4942424.8609	370.3693	394.8881
368SSD05	568678.5464	4839145.0029	388.6436	414.8141
368SSD06	605687.7767	4806073.8534	375.8463	402.0193
AC7894	549016.1436	5000510.7875	371.6924	396.1318
AC7901	629435.0083	4771218.9022	381.7834	407.5541
AC7935	651907.9103	4812771.3508	387.4296	413.6162
AC7967	695381.0046	4747012.7324	328.9431	354.5871
AC8003	575476.2048	4971475.2176	395.9010	420.3459
KFSD	682773.2995	4828178.8605	406.7137	433.0136
QQ1162	602443.5728	4835576.7017	389.1169	415.1584

OUTPUT VARIANCE/COVARIANCE

STA_ID	SE/SN/SUP (95.00 %) (m)	----- CX matrix (m)----- (not scaled by confidence level) (ECEF, XYZ cartesian)
368SSD01	0.0123 0.0152 0.0296	2.7042e-005 1.1993e-005 9.3309e-005 -7.6524e-006 -5.3191e-005 8.8983e-005
368SSD02	0.0143 0.0180 0.0350	3.6753e-005 1.6487e-005 1.3119e-004 -1.0948e-005 -7.4697e-005 1.2488e-004
368SSD03	0.0158 0.0192 0.0381	4.6272e-005 2.3304e-005 1.4763e-004 -1.3068e-005 -8.9412e-005 1.5220e-004
368SSD05	0.0171 0.0203 0.0411	5.2939e-005 2.4885e-005 1.8586e-004 -1.3132e-005 -1.0520e-004 1.6008e-004
368SSD06	0.0182 0.0208 0.0441	5.9788e-005 2.6999e-005 2.1220e-004 -1.6381e-005 -1.2421e-004 1.7979e-004
AC7894	0.0108 0.0112 0.0120	1.9561e-005 7.9035e-007 2.2486e-005 3.3423e-007 -1.5691e-006 2.2351e-005
AC7901	0.0096 0.0103 0.0116	1.5531e-005 1.0525e-006 2.0110e-005 -6.1511e-008 -2.5215e-006 1.9839e-005
AC7935	0.0094 0.0101 0.0115	1.5045e-005 1.0747e-006 1.9820e-005 -2.6364e-007 -2.4660e-006 1.9288e-005
AC7967	0.0116 0.0119 0.0121	2.2406e-005 5.1186e-007 2.4096e-005 1.7229e-009 -4.4970e-007 2.4073e-005
AC8003	0.0102 0.0108 0.0118	1.7437e-005 9.9724e-007 2.1265e-005 2.4823e-007 -2.1030e-006 2.1272e-005
KFSD	0.0148 0.0189 0.0356	3.9817e-005 2.0566e-005 1.3583e-004 -1.1620e-005 -7.5082e-005 1.3252e-004



Error! Reference source not found.South Dakota LiDAR Project
Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

File: 368SSD12-1 FullyCon Network West.net

GrafNet v7.80.2517

```
OQ1162      0.0092  1.4283e-005
             0.0098  1.0528e-006 1.9235e-005
             0.0114 -2.8066e-007 -2.8134e-006 1.8524e-005
```

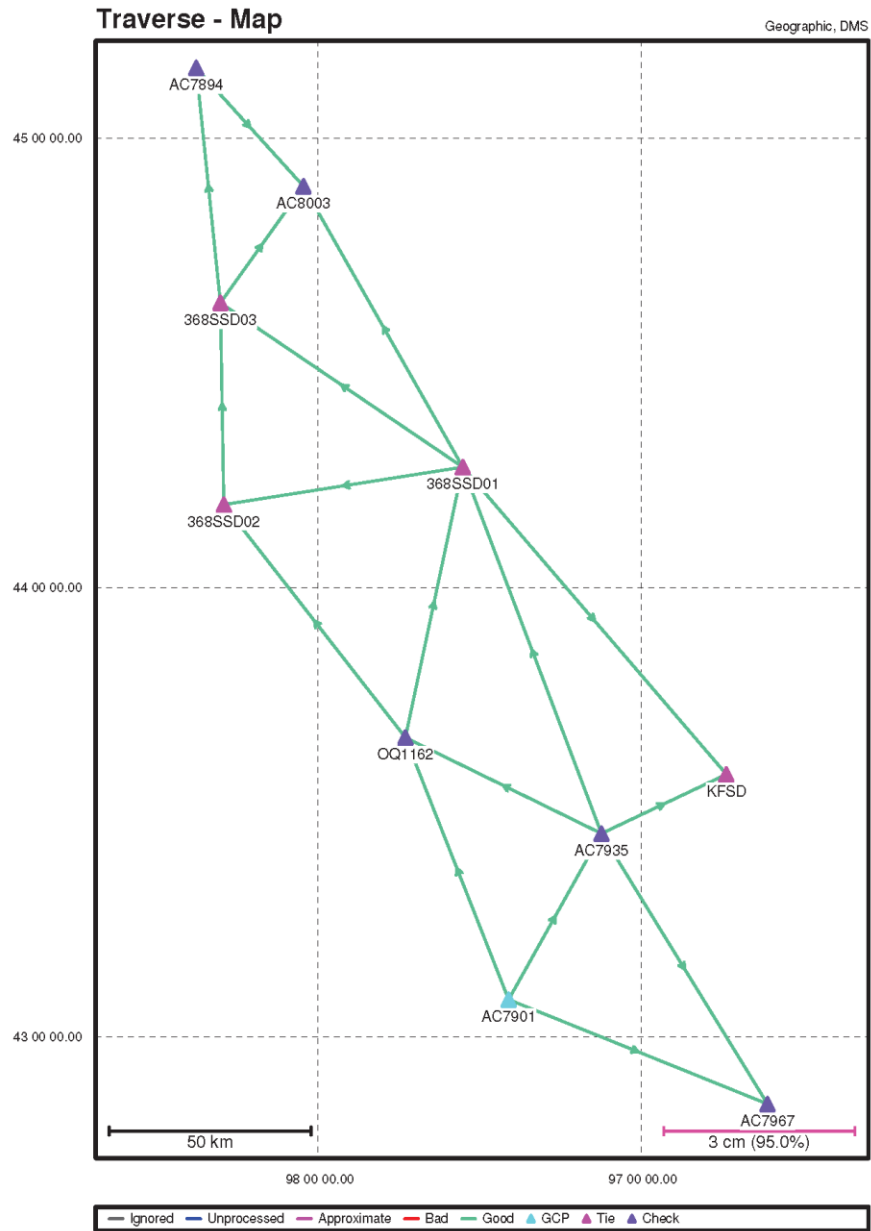
```
*****
VARIANCE FACTOR = 1.1212

Note: Values < 1.0 indicate statistics are pessimistic, while
      values > 1.0 indicate optimistic statistics. Entering this
      value as the network adjustment scale factor will bring
      variance factor to one.
*****
```

Un-Constrained Network West

Project: 368SSD12-1 Uncon Network West

GrafNet v7.80.2517





Error! Reference source not found.South Dakota LiDAR Project
Report

GDI #:368_SSD12-1 **Error! Reference
source not found.****Error!
Reference source not found.**



Error! Reference source not found.South Dakota LiDAR Project
Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

File: 368SSD12-1 Uncon Network West.net

GrafNet v7.80.2517

```
*****
* NETWORK - WEIGHTED GPS NETWORK ADJUSTMENT          *
* (c) Copyright NovAtel Inc., (2007)                  *
* Version: 7.80.2517                                   *
* FILE: C:\Projects\368 SSD 12\2_Operations\4_Control\Grafnet Project\368S *
SD12-1 Uncon Network West.net
*****
```

DATE(m/d/y): Mon. 4/23/12 TIME: 13:08:09

DATUM: 'NAD83_CORS96'
GRID: UTM, Zone 14
SCALE_FACTOR: 59.9540
CONFIDENCE LEVEL: 95.00 % (Scale factor is 2.4479)

INPUT CONTROL/CHECK POINTS

STA_ID	TYPE	-- LATITUDE --	-- LONGITUDE --	ELLHGT --	HZ-SD	V-SD
AC7894	CHK-3D	45 09 22.94132	-98 22 35.00326	371.693		
AC7901	GCP-3D	43 04 57.50473	-97 24 35.58390	381.786	0.00500	0.00500
AC7935	CHK-3D	43 27 08.77685	-97 07 20.90762	387.429		
AC7967	CHK-3D	42 51 02.63636	-96 36 31.55856	328.943		
AC8003	CHK-3D	44 53 33.72035	-98 02 38.93491	395.903		
QQ1162	CHK-3D	43 39 58.08703	-97 43 45.64149	389.114		

INPUT VECTORS

SESSION NAME	VECTOR(m)	----- Covariance (m) [unscaled] -----
	DX/DY/DZ	standard deviations in brackets
368SSD01 to 368SSD02 (1)	-59404.0202 2.9369e-007 (0.0005)	
	1806.1359 -3.5105e-009 1.9012e-007 (0.0004)	
	-6714.3252 -1.3352e-008 -1.1096e-007 1.3999e-007 (0.0004)	
368SSD01 to 368SSD03 (1)	-55176.9621 8.9377e-006 (0.0030)	
	36448.4510 -2.4273e-006 3.6273e-006 (0.0019)	
	28895.2527 5.5172e-007 -2.0926e-006 3.2528e-006 (0.0018)	
368SSD01 to 368SSD03 (2)	-55176.9439 1.5206e-006 (0.0012)	
	36448.4381 -1.4327e-008 5.2342e-007 (0.0007)	
	28895.2743 -5.6847e-008 -3.3185e-007 4.4214e-007 (0.0007)	
368SSD01 to AC8003 (1)	-32115.9156 1.7214e-006 (0.0013)	
	53646.5528 -7.1063e-008 5.8690e-007 (0.0008)	
	49402.1211 -3.3963e-008 -3.7283e-007 4.9725e-007 (0.0007)	
368SSD01 to KFSD (1)	58459.8043 3.3626e-006 (0.0018)	
	-60394.2953 3.0302e-007 8.4393e-007 (0.0009)	
	-54765.5467 -2.3987e-007 -5.1826e-007 6.6112e-007 (0.0008)	
368SSD01 to KFSD (2)	58459.8309 1.3609e-006 (0.0012)	

File: 368SSD12-1 Uncon Network West.net

GrafNet v7.80.2517

```

-60394.3098 -1.3446e-007 8.8962e-007 {0.0009}
-54765.5517 -8.2552e-009 -4.6043e-007 5.6120e-007 {0.0007}

368SSD02 to 368SSD03 (1) 4227.0467 7.7866e-006 {0.0028}
34642.3139 -2.1318e-006 3.1320e-006 {0.0018}
35609.5798 4.5916e-007 -1.7865e-006 2.7814e-006 {0.0017}

368SSD03 to AC7894 (1) 105.8078 3.9678e-006 {0.0020}
41472.1986 7.3625e-007 1.2091e-006 {0.0011}
41202.0767 -3.7284e-007 -6.9242e-007 9.2902e-007 {0.0010}

368SSD03 to AC8003 (1) 23061.0339 2.4158e-007 {0.0005}
17198.1175 1.2604e-007 6.8531e-007 {0.0008}
20506.8443 -6.6466e-008 -4.5958e-007 8.1595e-007 {0.0009}

AC7894 to AC8003 (1) 22955.2346 4.4827e-007 {0.0007}
-24274.0739 4.3800e-007 1.9776e-006 {0.0014}
-20695.2393 -1.4999e-007 -1.0437e-006 1.8294e-006 {0.0014}

AC7901 to AC7935 (1) 26708.8245 1.7602e-006 {0.0013}
24979.0231 -4.9363e-007 5.8684e-007 {0.0008}
29921.2640 6.9322e-008 -2.0963e-007 2.2548e-007 {0.0005}

AC7901 to AC7935 (2) 26708.8548 3.8351e-007 {0.0006}
24978.9947 -1.4497e-007 3.4682e-007 {0.0006}
29921.2532 3.1859e-008 -1.6335e-007 1.7484e-007 {0.0004}

AC7901 to AC7967 (1) 62735.5421 3.9667e-006 {0.0020}
-25366.5665 -1.3611e-006 4.2408e-006 {0.0021}
-18889.2465 4.7411e-007 -1.6737e-006 1.8650e-006 {0.0014}

AC7901 to OQ1162 (1) -19801.6706 4.1873e-006 {0.0020}
47540.1019 -7.8978e-007 1.0804e-006 {0.0010}
47128.7714 -1.5819e-008 -3.0253e-007 4.0965e-007 {0.0006}

AC7935 to 368SSD01 (1) -26230.8920 2.8878e-006 {0.0017}
66615.7784 3.6513e-007 8.1397e-007 {0.0009}
65392.3577 -2.1073e-007 -5.0142e-007 6.1694e-007 {0.0008}

AC7935 to AC7967 (1) 36026.6815 4.1571e-006 {0.0020}
-50345.5582 -1.4137e-006 4.5170e-006 {0.0021}
-48810.5046 5.3022e-007 -1.8256e-006 2.0308e-006 {0.0014}

AC7935 to KFSD (1) 32228.9154 8.5639e-008 {0.0003}
6221.4894 5.4181e-008 3.5353e-007 {0.0006}
10626.8032 -3.3312e-008 -2.1291e-007 3.4268e-007 {0.0006}

AC7935 to KFSD (2) 32228.9298 1.5860e-007 {0.0004}
6221.4720 1.5720e-007 7.2829e-007 {0.0009}
10626.8131 -5.6787e-008 -3.9848e-007 7.4759e-007 {0.0009}

AC7935 to OQ1162 (1) -46510.4890 5.3945e-006 {0.0023}
22561.0612 1.9016e-006 1.9056e-006 {0.0014}
17207.5260 -7.7023e-007 -9.5344e-007 1.0601e-006 {0.0010}

AC7935 to OQ1162 (2) -46510.4945 9.3744e-006 {0.0031}
22561.0785 -3.0954e-006 3.2611e-006 {0.0018}
17207.5045 6.6396e-007 -1.1500e-006 1.1744e-006 {0.0011}

AC7935 to OQ1162 (3) -46510.4980 3.9275e-006 {0.0020}
22561.0643 4.8026e-008 5.2216e-006 {0.0023}
17207.5223 -2.0893e-007 -1.9729e-006 2.4182e-006 {0.0016}

OQ1162 to 368SSD02 (1) -39124.4240 4.6401e-007 {0.0007}
45860.8573 1.6113e-008 3.3389e-007 {0.0006}
41470.5055 -3.7602e-008 -1.9325e-007 2.3807e-007 {0.0005}

```



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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File: 368SSD12-1 Uncon Network West.net

GrafNet v7.80.2517

OQ1162 to 368SSD01 (1) 20279.5984 4.4762e-007 {0.0007}
44054.7232 1.4639e-008 3.2142e-007 {0.0006}
48184.8283 -3.6506e-008 -1.8688e-007 2.2580e-007 {0.0005}

OUTPUT VECTOR RESIDUALS (East, North, Height - Local Level)

SESSION NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)	- PPM -	DIST - (km)	STD - (m)
368SSD01 to 368SSD02 (1)	0.0001	0.0006	-0.0005	0.014	59.8	0.0061
368SSD01 to 368SSD03 (1)	0.0137	0.0064	0.0211	0.359	72.2	0.0308
368SSD01 to 368SSD03 (2)	-0.0061	-0.0017	-0.0013	0.089	72.2	0.0122
368SSD01 to AC8003 (1)	-0.0006	-0.0004	-0.0036	0.046	79.7	0.0130
368SSD01 to KFSD (1)	0.0139	-0.0049	0.0041	0.153	100.3	0.0171
368SSD01 to KFSD (2)	-0.0143	0.0065	-0.0004	0.156	100.3	0.0130
368SSD02 to 368SSD03 (1)	0.0247	0.0066	0.0182	0.629	49.9	0.0287
368SSD03 to AC7894 (1)	-0.0064	-0.0009	0.0056	0.146	58.5	0.0191
368SSD03 to AC8003 (1)	0.0004	0.0007	0.0021	0.062	35.3	0.0102
AC7894 to AC8003 (1)	-0.0006	0.0006	0.0072	0.186	39.3	0.0160
AC7901 to AC7935 (1)	0.0235	-0.0143	0.0039	0.589	47.3	0.0124
AC7901 to AC7935 (2)	-0.0101	0.0102	-0.0064	0.332	47.3	0.0074
AC7901 to AC7967 (1)	-0.0079	0.0040	-0.0056	0.149	70.3	0.0246
AC7901 to OQ1162 (1)	0.0275	-0.0116	0.0195	0.511	69.8	0.0184
AC7935 to 368SSD01 (1)	-0.0048	0.0018	-0.0103	0.119	97.0	0.0161
AC7935 to AC7967 (1)	0.0082	-0.0042	0.0059	0.139	78.8	0.0253
AC7935 to KFSD (1)	0.0068	-0.0020	0.0041	0.237	34.5	0.0068
AC7935 to KFSD (2)	-0.0096	0.0015	-0.0140	0.494	34.5	0.0099
AC7935 to OQ1162 (1)	-0.0045	0.0007	-0.0092	0.188	54.5	0.0224
AC7935 to OQ1162 (2)	0.0032	0.0049	0.0175	0.339	54.5	0.0288
AC7935 to OQ1162 (3)	0.0048	0.0020	-0.0053	0.136	54.5	0.0263
OQ1162 to 368SSD02 (1)	0.0011	-0.0005	0.0020	0.032	73.2	0.0079
OQ1162 to 368SSD01 (1)	-0.0010	-0.0007	0.0057	0.085	68.4	0.0077
RMS	0.0115	0.0054	0.0097			

\$ - This session is flagged as a 3-sigma outlier

CHECK POINT RESIDUALS (East, North, Height - Local Level)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
AC7894	0.0094	0.0050	-0.0396
AC7935	0.0153	0.0127	0.0163
AC7967	-0.0251	0.0027	-0.0293
AC8003	0.0074	0.0114	-0.0398
OQ1162	0.0171	0.0191	0.0190
RMS	0.0161	0.0117	0.0304

CONTROL POINT RESIDUALS (ADJUSTMENT MADE)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
AC7901	-0.0000	0.0000	-0.0000



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GDI #:368_SSD12-1 **Error! Reference source not found.**
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File: 368SSD12-1 Uncon Network West.net

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AC7935	0.0161	4.1909e-005		
	0.0129	-5.3735e-006	3.5750e-005	
	0.0148	9.1366e-007	-4.5171e-006	2.9971e-005
AC7967	0.0310	1.5073e-004		
	0.0194	-4.2863e-005	1.5865e-004	
	0.0319	1.5210e-005	-5.3384e-005	8.4426e-005
AC8003	0.0259	1.1140e-004		
	0.0151	-4.8144e-006	6.7449e-005	
	0.0226	-1.9585e-006	-2.3615e-005	5.6794e-005
KFSD	0.0166	4.4912e-005		
	0.0137	-3.5296e-006	4.5392e-005	
	0.0176	-9.8940e-008	-1.0034e-005	3.8642e-005
OQ1162	0.0204	6.8916e-005		
	0.0137	-4.4523e-006	4.4815e-005	
	0.0170	-4.8673e-007	-8.4068e-006	3.5551e-005

VARIANCE FACTOR = 1.7487

Note: Values < 1.0 indicate statistics are pessimistic, while
values > 1.0 indicate optimistic statistics. Entering this
value as the network adjustment scale factor will bring
variance factor to one.



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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NGS Data Sheets, Set Point Station Descriptions and Photos

AC7894 CBN - This is a Cooperative Base Network Control Station.
AC7894 DESIGNATION - 20 328.35
AC7894 PID - AC7894
AC7894 STATE/COUNTY- SD/SPINK
AC7894 USGS QUAD - MELLETTE (1954)

AC7894
AC7894 *CURRENT SURVEY CONTROL

AC7894*	NAD 83 (2007)-	45 09 22.94133(N)	098 22 35.00326(W)	ADJUSTED
AC7894*	NAVD 88	396.1 (meters)	1300. (feet)	GPS OBS

AC7894	EPOCH DATE	-	2002.00		
AC7894	X	-	-656,347.330 (meters)		COMP
AC7894	Y	-	-4,457,484.813 (meters)		COMP
AC7894	Z	-	4,499,883.413 (meters)		COMP
AC7894	LAPLACE CORR-		-1.78 (seconds)		DEFLEC09
AC7894	ELLIP HEIGHT-		371.693 (meters)	(02/10/07)	ADJUSTED
AC7894	GEOID HEIGHT-		-24.44 (meters)		GEOID09

AC7894
AC7894 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
AC7894 Type PID Designation North East Ellip
AC7894
AC7894 NETWORK AC7894 20 328.35 0.88 0.63 2.67
AC7894 -----

AC7894
AC7894 The horizontal coordinates were established by GPS observations
AC7894 and adjusted by the National Geodetic Survey in February 2007.
AC7894
AC7894 The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AC7894 See [National Readjustment](#) for more information.
AC7894
AC7894 The horizontal coordinates are valid at the epoch date displayed above
AC7894 which is a decimal equivalence of Year/Month/Day.
AC7894
AC7894 The orthometric height was determined by GPS observations and a
AC7894 high-resolution geoid model.
AC7894
AC7894 The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC7894
AC7894 The Laplace correction was computed from DEFLEC09 derived deflections.
AC7894
AC7894 The ellipsoidal height was determined by GPS observations
AC7894 and is referenced to NAD 83.
AC7894
AC7894 The geoid height was determined by GEOID09.

AC7894			North	East	Units	Scale	Factor	Converg.
AC7894;SPC	SD N	-	148,299.901	727,651.719	MT	0.99994079		+1 08 56.7
AC7894;SPC	SD N	-	486,547.26	2,387,304.01	sFT	0.99994079		+1 08 56.7
AC7894;UTM	14	-	5,000,510.788	549,016.145	MT	0.99962954		+0 26 31.8
AC7894								



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Report

GDI #:368_SSD12-1 **Error! Reference
source not found.****Error!
Reference source not found.**



Error! Reference source not found.South Dakota LiDAR Project
Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

AC7894! - Elev Factor x Scale Factor = Combined Factor
AC7894!SPC SD N - 0.99994173 x 0.99994079 = 0.99988252
AC7894!UTM 14 - 0.99994173 x 0.99962954 = 0.99957129
AC7894
AC7894 SUPERSEDED SURVEY CONTROL
AC7894
AC7894 ELLIP H (04/15/04) 371.710 (m) GP() 2 1
AC7894 NAD 83(1996)- 45 09 22.94081(N) 098 22 35.00271(W) AD() B
AC7894 ELLIP H (04/18/97) 371.736 (m) GP() 4 1
AC7894
AC7894.Superseded values are not recommended for survey control.
AC7894.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AC7894.[See file dsdata.txt](#) to determine how the superseded data were derived.
AC7894
AC7894_U.S. NATIONAL GRID SPATIAL ADDRESS: 14TNR4901600510(NAD 83)
AC7894
AC7894_MARKER: Z = SEE DESCRIPTION
AC7894_SETTING: 47 = GALVANIZED STEEL PIPE W/O SLEEVE (10 FT.)
AC7894_STAMPING: 20-328.35 1995
AC7894_MARK LOGO: NGS
AC7894_PROJECTION: FLUSH
AC7894_MAGNETIC: P = MARKER IS A STEEL PIPE
AC7894_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
AC7894_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AC7894+SATELLITE: SATELLITE OBSERVATIONS - July 09, 1996
AC7894_ROD/PIPE-DEPTH: 6.4 meters
AC7894
AC7894 HISTORY - Date Condition Report By
AC7894 HISTORY - 1995 MONUMENTED SDDT
AC7894 HISTORY - 19960709 GOOD NGS
AC7894
AC7894 STATION DESCRIPTION
AC7894
AC7894'DESCRIBED BY NATIONAL GEODETIC SURVEY 1996 (DFC)
AC7894'THE STATION IS LOCATED ABOUT 6.0 MI (9.7 KM) EAST OF MELLETTE AND 2.4
AC7894'MI (3.9 KM) WEST OF BRENTFORD, ON STATE HIGHWAY 20. OWNERSHIP--THE
AC7894'STATE OF SOUTH DAKOTA. TO REACH THE STATION FROM THE JUNCTION OF
AC7894'STATE HIGHWAY 20 AND COUNTY ROAD 11, 0.1 MI (0.2 KM) WEST OF
AC7894'BRENTFORD, GO WEST ON STATE HIGHWAY 20 FOR 2.3 MI (3.7 KM) TO THE
AC7894'STATION ON THE LEFT. THE STATION IS A PUNCH POINT ON TOP OF A
AC7894'STAINLESS STEEL RIVET FASTENED TO A METAL PIPE CAP ATTACHED TO A 1
AC7894'1/2-INCH GALVANIZED STEEL PIPE. LOCATED 21.9 M (71.9 FT) SOUTH OF THE
AC7894'HIGHWAY CENTERLINE, 7.5 M (24.6 FT) SOUTHEAST OF THE EAST END OF A
AC7894'CONCRETE PIPE CULVERT, 6.7 M (22.0 FT) EAST OF THE CENTER OF A FIELD
AC7894'ENTRANCE, 0.3 M (1.0 FT) SOUTH OF A METAL GUARD POST, AND 0.3 M (1.0
AC7894'FT) NORTH OF A WITNESS POST. NOTE--ACCESS TO THE DATUM POINT IS
AC7894'THROUGH A 5-INCH LOGO CAP.



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GDI #:368_SSD12-1 **Error! Reference source not found.**
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AC7901 CBN - This is a Cooperative Base Network Control Station.
AC7901 DESIGNATION - 46 334.00
AC7901 PID - AC7901
AC7901 STATE/COUNTY- SD/YANKTON
AC7901 USGS QUAD - JAMESVILLE (1957)
AC7901
AC7901 *CURRENT SURVEY CONTROL
AC7901
AC7901* NAD 83(2007)- 43 04 57.50474(N) 097 24 35.58390(W) ADJUSTED
AC7901* NAVD 88 - 407.6 (meters) 1337. (feet) GPS OBS
AC7901
AC7901 EPOCH DATE - 2002.00
AC7901 X - -601,754.117 (meters) COMP
AC7901 Y - -4,627,000.212 (meters) COMP
AC7901 Z - 4,334,472.428 (meters) COMP
AC7901 LAPLACE CORR- 1.04 (seconds) DEFLEC09
AC7901 ELLIP HEIGHT- 381.786 (meters) (02/10/07) ADJUSTED
AC7901 GEOID HEIGHT- -25.77 (meters) GEOID09
AC7901
AC7901 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
AC7901 Type PID Designation North East Ellip
AC7901
AC7901 NETWORK AC7901 46 334.00 0.69 0.51 2.37
AC7901
AC7901
AC7901.The horizontal coordinates were established by GPS observations
AC7901.and adjusted by the National Geodetic Survey in February 2007.
AC7901
AC7901.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AC7901.See National Readjustment for more information.
AC7901
AC7901.The horizontal coordinates are valid at the epoch date displayed above
AC7901.which is a decimal equivalence of Year/Month/Day.
AC7901
AC7901.The orthometric height was determined by GPS observations and a
AC7901.high-resolution geoid model.
AC7901
AC7901.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC7901
AC7901.The Laplace correction was computed from DEFLEC09 derived deflections.
AC7901
AC7901.The ellipsoidal height was determined by GPS observations
AC7901.and is referenced to NAD 83.
AC7901
AC7901.The geoid height was determined by GEOID09.
AC7901
AC7901; North East Units Scale Factor Converg.
AC7901;SPC SD S - 87,430.640 838,000.148 MT 0.99995030 +2 01 00.3
AC7901;SPC SD S - 286,845.36 2,749,338.82 sFT 0.99995030 +2 01 00.3
AC7901;UTM 14 - 4,771,218.904 629,435.008 MT 0.99980610 +1 05 10.6
AC7901
AC7901! - Elev Factor x Scale Factor = Combined Factor
AC7901!SPC SD S - 0.99994013 x 0.99995030 = 0.99989043
AC7901!UTM 14 - 0.99994013 x 0.99980610 = 0.99974624
AC7901

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Error! Reference source not found.South Dakota LiDAR Project
Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

AC7901 SUPERSEDED SURVEY CONTROL
AC7901
AC7901 ELLIP H (04/15/04) 381.784 (m) GP () 2 1
AC7901 NAD 83(1996)- 43 04 57.50452(N) 097 24 35.58353(W) AD () B
AC7901 ELLIP H (04/18/97) 381.816 (m) GP () 4 1
AC7901
AC7901.Superseded values are not recommended for survey control.
AC7901.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AC7901.[See file dsdata.txt](#) to determine how the superseded data were derived.
AC7901
AC7901_U.S. NATIONAL GRID SPATIAL ADDRESS: 14TPN2943571218(NAD 83)
AC7901
AC7901_MARKER: Z = SEE DESCRIPTION
AC7901_SETTING: 57 = GALVANIZED STEEL PIPE IN SLEEVE (10 FT.)
AC7901_STAMPING: 46-334.00 1995
AC7901_PROJECTION: FLUSH
AC7901_MAGNETIC: P = MARKER IS A STEEL PIPE
AC7901_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
AC7901_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AC7901+SATELLITE: SATELLITE OBSERVATIONS - September 25, 1996
AC7901_ROD/PIPE-DEPTH: 6.4 meters
AC7901_SLEEVE-DEPTH : 1.8 meters
AC7901
AC7901 HISTORY - Date Condition Report By
AC7901 HISTORY - 1994 MONUMENTED SDDT
AC7901 HISTORY - 19960925 GOOD SDDT
AC7901
AC7901 STATION DESCRIPTION
AC7901
AC7901'DESCRIBED BY SD DEPT OF TRANSP 1996 (DFC)
AC7901'THE STATION IS LOCATED 9.0 MI (14.5 KM) NORTHEAST OF LESTERVILLE AND
AC7901'5.0 MI (8.0 KM) WEST OF MAYFIELD, ON STATE HIGHWAY 46. OWNERSHIP--THE
AC7901'STATE OF SOUTH DAKOTA. TO REACH THE STATION FROM THE JUNCTION OF
AC7901'STATE HIGHWAY 46 AND A NORTH/SOUTH PAVED COUNTY ROAD IN MAYFIELD, GO
AC7901'WEST ON STATE HIGHWAY 46 FOR 4.8 MI (7.7 KM) TO STATION ON THE LEFT.
AC7901'THE STATION IS A PUNCH POINT ON TOP OF A STAINLESS STEEL RIVET
AC7901'FASTENED TO A METAL PIPE CAP ATTACHED TO A 1 1/2-INCH GALVANIZED STEEL
AC7901'PIPE. LOCATED 87.0 FT (26.5 M) SOUTH OF CENTER OF THE HIGHWAY, 54.0
AC7901'FT (16.5 M) SOUTH OF MILEPOST 334, 2.0 FT (0.6 M) NORTH OF A WITNESS
AC7901'POST AND FENCE, AND 1.0 FT (0.3 M) SOUTH OF A METAL GUARD POST.
AC7901'NOTE--ACCESS TO THE DATUM POINT IS THROUGH A 5-INCH LOGO CAP AND THEN
AC7901'A 4-INCH PVC CAP.



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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AC7935 CBN - This is a Cooperative Base Network Control Station.
AC7935 DESIGNATION - 19 057.75
AC7935 PID - AC7935
AC7935 STATE/COUNTY- SD/TURNER
AC7935 USGS QUAD - PARKER NE (1968)
AC7935
AC7935 *CURRENT SURVEY CONTROL
AC7935
AC7935* NAD 83(2007)- 43 27 08.77686(N) 097 07 20.90762(W) ADJUSTED
AC7935* NAVD 88 - 413.6 (meters) 1357. (feet) GPS OBS
AC7935
AC7935 EPOCH DATE - 2002.00
AC7935 X - -575,045.286 (meters) COMP
AC7935 Y - -4,602,021.200 (meters) COMP
AC7935 Z - 4,364,393.664 (meters) COMP
AC7935 LAPLACE CORR- -1.58 (seconds) DEFLEC09
AC7935 ELLIP HEIGHT- 387.429 (meters) (02/10/07) ADJUSTED
AC7935 GEOID HEIGHT- -26.19 (meters) GEOID09
AC7935
AC7935 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
AC7935 Type PID Designation North East Ellip
AC7935
AC7935 NETWORK AC7935 19 057.75 0.71 0.57 2.45
AC7935
AC7935
AC7935.The horizontal coordinates were established by GPS observations
AC7935.and adjusted by the National Geodetic Survey in February 2007.
AC7935
AC7935.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AC7935.See [National Readjustment](#) for more information.
AC7935
AC7935.The horizontal coordinates are valid at the epoch date displayed above
AC7935.which is a decimal equivalence of Year/Month/Day.
AC7935
AC7935.The orthometric height was determined by GPS observations and a
AC7935.high-resolution geoid model.
AC7935
AC7935.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC7935
AC7935.The Laplace correction was computed from DEFLEC09 derived deflections.
AC7935
AC7935.The ellipsoidal height was determined by GPS observations
AC7935.and is referenced to NAD 83.
AC7935
AC7935.The geoid height was determined by GEOID09.
AC7935
AC7935;
AC7935; North East Units Scale Factor Converg.
AC7935;SPC SD S - 129,344.794 859,799.520 MT 0.99991105 +2 12 54.1
AC7935;SPC SD S - 424,358.71 2,820,858.93 sFT 0.99991105 +2 12 54.1
AC7935;UTM 14 - 4,812,771.350 651,907.909 MT 0.99988386 +1 17 29.5
AC7935
AC7935!
AC7935!SPC SD S - Elev Factor x Scale Factor = Combined Factor
AC7935!SPC SD S - 0.99993925 x 0.99991105 = 0.99985030
AC7935!UTM 14 - 0.99993925 x 0.99988386 = 0.99982312
AC7935



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

AC7935 SUPERSEDED SURVEY CONTROL
AC7935
AC7935 ELLIP H (04/15/04) 387.445 (m) GP () 2 1
AC7935 NAD 83(1996)- 43 27 08.77649(N) 097 07 20.90702(W) AD () B
AC7935 ELLIP H (04/18/97) 387.460 (m) GP () 4 1
AC7935
AC7935.Superseded values are not recommended for survey control.
AC7935.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AC7935.[See file dsdata.txt](#) to determine how the superseded data were derived.
AC7935
AC7935_U.S. NATIONAL GRID SPATIAL ADDRESS: 14TPP5190712771(NAD 83)
AC7935
AC7935_MARKER: Z = SEE DESCRIPTION
AC7935_SETTING: 57 = GALVANIZED STEEL PIPE IN SLEEVE (10 FT.+))
AC7935_STAMPING: 19-57.75 1995
AC7935_MARK LOGO: NGS
AC7935_PROJECTION: FLUSH
AC7935_MAGNETIC: P = MARKER IS A STEEL PIPE
AC7935_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
AC7935_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AC7935+SATELLITE: SATELLITE OBSERVATIONS - February 04, 2005
AC7935_ROD/PIPE-DEPTH: 6.4 meters
AC7935_SLEEVE-DEPTH : 1.8 meters
AC7935
AC7935 HISTORY - Date Condition Report By
AC7935 HISTORY - 1995 MONUMENTED SDDT
AC7935 HISTORY - 19960927 GOOD NGS
AC7935 HISTORY - 20050204 GOOD INDIV
AC7935
AC7935 STATION DESCRIPTION
AC7935
AC7935'DESCRIBED BY NATIONAL GEODETIC SURVEY 1996 (DFC)
AC7935'THE STATION IS LOCATED ABOUT 14.7 MI (23.7 KM) SOUTH-SOUTHWEST OF
AC7935'PUMPKIN CENTER, 3.0 MI (4.8 KM) NORTH OF PARKER, AND 3.5 MI (5.6 KM)
AC7935'SOUTH OF THE TURNER/MINNEHAHA COUNTY LINE, ON STATE HIGHWAY 19.
AC7935'OWNERSHIP--THE STATE OF SOUTH DAKOTA. TO REACH THE STATION FROM THE
AC7935'JUNCTION OF STATE HIGHWAYS 19 AND 44 ON THE EAST SIDE OF PARKER, GO
AC7935'NORTH ON U.S. HIGHWAY 19 FOR 3.7 KM (2.30 MI) TO THE STATION ON THE
AC7935'LEFT. THE STATION IS A PUNCH POINT ON TOP OF A STAINLESS STEEL RIVET
AC7935'FASTENED TO A METAL PIPE CAP ATTACHED TO A 1 1/2-INCH GALVANIZED STEEL
AC7935'PIPE. LOCATED 74.0 FT (22.6 M) WEST OF THE HIGHWAY CENTER, 15.0 FT
AC7935'(4.6 M) NORTH OF THE CENTER OF A FIELD ENTRANCE ROAD, 2.0 FT (0.6 M)
AC7935'EAST OF A WITNESS POST AND FENCE, AND 1.0 FT (0.3 M) WEST OF A METAL
AC7935'GUARD POST. NOTE--ACCESS TO THE DATUM POINT IS THROUGH A 5-INCH LOGO
AC7935'CAP AND THEN A 4-INCH PVC CAP.
AC7935
AC7935 STATION RECOVERY (2005)
AC7935
AC7935'RECOVERY NOTE BY INDIVIDUAL CONTRIBUTORS 2005
AC7935'RECOVERED IN GOOD CONDITION.





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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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AC7967 *****
AC7967 CBN - This is a Cooperative Base Network Control Station.
AC7967 DESIGNATION - 48 381.53
AC7967 PID - AC7967
AC7967 STATE/COUNTY- SD/UNION
AC7967 USGS QUAD - JEFFERSON (1994)
AC7967
AC7967 *CURRENT SURVEY CONTROL
AC7967
AC7967* NAD 83(2007)- 42 51 02.63637(N) 096 36 31.55856(W) ADJUSTED
AC7967* NAVD 88 - 354.6 (meters) 1163. (feet) GPS OBS
AC7967
AC7967 EPOCH DATE - 2002.00
AC7967 X - -539,018.560 (meters) COMP
AC7967 Y - -4,652,366.797 (meters) COMP
AC7967 Z - 4,315,583.199 (meters) COMP
AC7967 LAPLACE CORR- -3.31 (seconds) DEFLEC09
AC7967 ELLIP HEIGHT- 328.943 (meters) (02/10/07) ADJUSTED
AC7967 GEOID HEIGHT- -25.64 (meters) GEOID09
AC7967
AC7967 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
AC7967 Type PID Designation North East Ellip
AC7967
AC7967 NETWORK AC7967 48 381.53 0.59 0.45 1.84
AC7967
AC7967
AC7967.The horizontal coordinates were established by GPS observations
AC7967.and adjusted by the National Geodetic Survey in February 2007.
AC7967
AC7967.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AC7967.See National Readjustment for more information.
AC7967
AC7967.The horizontal coordinates are valid at the epoch date displayed above
AC7967.which is a decimal equivalence of Year/Month/Day.
AC7967
AC7967.The orthometric height was determined by GPS observations and a
AC7967.high-resolution geoid model.
AC7967
AC7967.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC7967
AC7967.The Laplace correction was computed from DEFLEC09 derived deflections.
AC7967
AC7967.The ellipsoidal height was determined by GPS observations
AC7967.and is referenced to NAD 83.
AC7967
AC7967.The geoid height was determined by GEOID09.
AC7967
AC7967; North East Units Scale Factor Converg.
AC7967;SPC SD S - 64,304.168 904,335.667 MT 0.99999593 +2 34 09.8
AC7967;SPC SD S - 210,971.26 2,966,974.60 sFT 0.99999593 +2 34 09.8
AC7967;UTM 14 - 4,747,012.733 695,381.004 MT 1.00006965 +1 37 36.4
AC7967
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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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AC7967! - Elev Factor x Scale Factor = Combined Factor
AC7967!SPC SD S - 0.99994842 x 0.99999593 = 0.99994435
AC7967!UTM 14 - 0.99994842 x 1.00006965 = 1.00001806
AC7967
AC7967 SUPERSEDED SURVEY CONTROL
AC7967
AC7967 ELLIP H (04/15/04) 328.940 (m) GP() 2 1
AC7967 NAD 83(1996)- 42 51 02.63617(N) 096 36 31.55819(W) AD() B
AC7967 ELLIP H (04/18/97) 328.982 (m) GP() 4 1
AC7967
AC7967.Superseded values are not recommended for survey control.
AC7967.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AC7967.[See file dsdata.txt](#) to determine how the superseded data were derived.
AC7967
AC7967_U.S. NATIONAL GRID SPATIAL ADDRESS: 14TPN9538147012(NAD 83)
AC7967
AC7967_MARKER: Z = SEE DESCRIPTION
AC7967_SETTING: 57 = GALVANIZED STEEL PIPE IN SLEEVE (10 FT.+)
AC7967_STAMPING: 48-381.53 1995
AC7967_MARK LOGO: NGS
AC7967_PROJECTION: FLUSH
AC7967_MAGNETIC: P = MARKER IS A STEEL PIPE
AC7967_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
AC7967_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AC7967+SATELLITE: SATELLITE OBSERVATIONS - September 28, 1996
AC7967_ROD/PIPE-DEPTH: 6.4 meters
AC7967_SLEEVE-DEPTH : 1.8 meters
AC7967
AC7967 HISTORY - Date Condition Report By
AC7967 HISTORY - 1994 MONUMENTED SDDT
AC7967 HISTORY - 19960928 GOOD NGS
AC7967 HISTORY - 19961205 GOOD NGS
AC7967
AC7967 STATION DESCRIPTION
AC7967
AC7967'DESCRIBED BY NATIONAL GEODETIC SURVEY 1996 (DFC)
AC7967'THE STATION IS LOCATED ABOUT 9.5 MI (15.3 KM) EAST OF INTERSTATE
AC7967'HIGHWAY 29 EXIT 31, 7.0 MI (11.3 KM) EAST OF SPINK, AND 3.0 MI (4.8
AC7967'KM) WEST OF THE SOUTH DAKOTA/MINNESOTA STATE LINE, ON STATE HIGHWAY
AC7967'48. OWNERSHIP--THE STATE OF SOUTH DAKOTA. TO REACH THE STATION FROM
AC7967'THE JUNCTION OF STATE HIGHWAY 48 AND COUNTY ROAD 21 IN SPINK, GO EAST
AC7967'ON STATE HIGHWAY 48 FOR 7.2 MI (11.6 KM) TO THE STATION ON THE RIGHT.
AC7967'THE STATION IS A PUNCH POINT ON TOP OF A STAINLESS STEEL RIVET
AC7967'FASTENED TO A METAL PIPE CAP ATTACHED TO A 1 1/2-INCH GALVANIZED STEEL
AC7967'PIPE. LOCATED 1.0 MI (1.6 KM) EAST OF THE JUNCTION OF STATE HIGHWAY
AC7967'11 NORTH, 0.13 MI (0.21 KM) WEST OF THE WEST END OF A BRIDGE, 85.5 FT
AC7967'(26.1 M) SOUTH OF THE HIGHWAY CENTER, 1.2 FT (0.4 M) NORTH OF A
AC7967'WITNESS POST AND FENCE, AND 1.0 FT (0.3 M) SOUTH OF METAL GUARD POST.
AC7967'NOTE--ACCESS TO THE DATUM POINT IS THROUGH A 5-INCH LOGO CAP AND THEN
AC7967'A 4-INCH PVC CAP.
AC7967
AC7967 STATION RECOVERY (1996)
AC7967
AC7967'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1996 (JDS)
AC7967'RECOVERED AS DESCRIBED--FULL DESCRIPTION SUBMITTED WITH SOUTH DAKOTA
AC7967'HARN PROJECT.



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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AC7987 *****
AC7987 CBN - This is a Cooperative Base Network Control Station.
AC7987 DESIGNATION - A 467
AC7987 PID - AC7987
AC7987 STATE/COUNTY- SD/CODINGTON
AC7987 USGS QUAD - WATERTOWN EAST (1969)
AC7987
AC7987 *CURRENT SURVEY CONTROL
AC7987
AC7987* NAD 83(2007)- 44 53 25.34837(N) 097 04 33.94998(W) ADJUSTED
AC7987* NAVD 88 - 527.287 (meters) 1729.94 (feet) ADJUSTED
AC7987
AC7987 EPOCH DATE - 2002.00
AC7987 X - -557,614.661 (meters) COMP
AC7987 Y - -4,492,076.061 (meters) COMP
AC7987 Z - 4,479,080.097 (meters) COMP
AC7987 LAPLACE CORR- -0.89 (seconds) DEFLEC09
AC7987 ELLIP HEIGHT- 502.205 (meters) (02/10/07) ADJUSTED
AC7987 GEOID HEIGHT- -25.09 (meters) GEOID09
AC7987 DYNAMIC HT - 527.209 (meters) 1729.68 (feet) COMP
AC7987
AC7987 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
AC7987 Type PID Designation North East Ellip
AC7987 -----
AC7987 NETWORK AC7987 A 467 0.71 0.53 2.33
AC7987 -----
AC7987 MODELED GRAV- 980,453.5 (mgal) NAVD 88
AC7987
AC7987 VERT ORDER - FIRST CLASS II
AC7987
AC7987.The horizontal coordinates were established by GPS observations
AC7987.and adjusted by the National Geodetic Survey in February 2007.
AC7987
AC7987.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AC7987.See National Readjustment for more information.
AC7987
AC7987.The horizontal coordinates are valid at the epoch date displayed above
AC7987.which is a decimal equivalence of Year/Month/Day.
AC7987
AC7987.The orthometric height was determined by differential leveling and
AC7987.adjusted in July 1998.
AC7987
AC7987.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC7987
AC7987.The Laplace correction was computed from DEFLEC09 derived deflections.
AC7987
AC7987.The ellipsoidal height was determined by GPS observations
AC7987.and is referenced to NAD 83.
AC7987
AC7987.The geoid height was determined by GEOID09.
AC7987
AC7987.The dynamic height is computed by dividing the NAVD 88
AC7987.geopotential number by the normal gravity value computed on the
AC7987.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
AC7987.degrees latitude (g = 980.6199 gals.).
AC7987
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GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

AC7987.The modeled gravity was interpolated from observed gravity values.
AC7987
AC7987;
AC7987;SPC SD N North East Units Scale Factor Converg.
AC7987;SPC SD N - 121,631.084 830,916.304 MT 0.99994303 +2 04 09.7
AC7987;SPC SD N - 399,051.31 2,726,097.91 sFT 0.99994303 +2 04 09.7
AC7987;UTM 14 - 4,972,572.989 651,921.990 MT 0.99988381 +1 21 29.0
AC7987
AC7987! - Elev Factor x Scale Factor = Combined Factor
AC7987!SPC SD N - 0.99992127 x 0.99994303 = 0.99986430
AC7987!UTM 14 - 0.99992127 x 0.99988381 = 0.99980509
AC7987
AC7987 SUPERSEDED SURVEY CONTROL
AC7987
AC7987 ELLIP H (04/15/04) 502.228 (m) GP () 2 1
AC7987 NAD 83(1996)- 44 53 25.34788(N) 097 04 33.94949(W) AD () B
AC7987 ELLIP H (04/18/97) 502.246 (m) GP () 4 1
AC7987 NAVD 88 (04/18/97) 527.3 (m) 1730. (f) GPS OBS
AC7987
AC7987.Superseded values are not recommended for survey control.
AC7987.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AC7987.[See file dsdata.txt](#) to determine how the superseded data were derived.
AC7987
AC7987_U.S. NATIONAL GRID SPATIAL ADDRESS: 14TPQ5192172572(NAD 83)
AC7987
AC7987_MARKER: I = METAL ROD
AC7987_SETTING: 59 = STAINLESS STEEL ROD IN SLEEVE (10 FT.+)
AC7987_STAMPING: A 467 1995
AC7987_MARK LOGO: NGS
AC7987_PROJECTION: FLUSH
AC7987_MAGNETIC: I = MARKER IS A STEEL ROD
AC7987_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
AC7987_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AC7987+SATELLITE: SATELLITE OBSERVATIONS - October 11, 1996
AC7987_ROD/PIPE-DEPTH: 12.3 meters
AC7987_SLEEVE-DEPTH : 0.9 meters
AC7987
AC7987 HISTORY - Date Condition Report By
AC7987 HISTORY - 1995 MONUMENTED NGS
AC7987 HISTORY - 19960612 GOOD NGS
AC7987 HISTORY - 19961011 GOOD CHANCE
AC7987
AC7987 STATION DESCRIPTION
AC7987
AC7987'DESCRIBED BY NATIONAL GEODETIC SURVEY 1996 (DFC)
AC7987'THE STATION IS LOCATED ABOUT 7.0 MI (11.3 KM) WEST OF KRAZENBURG, 6.6
AC7987'MI (10.6 KM) SOUTH-SOUTHEAST OF RAUVILLE, AND 2.0 MI (3.2 KM) EAST OF
AC7987'WATERTOWN, ON U.S. HIGHWAY 212. OWNERSHIP--THE STATE OF SOUTH DAKOTA.
AC7987'TO REACH THE STATION FROM THE JUNCTION OF INTERSTATE HIGHWAY 29 AND
AC7987'U.S. HIGHWAY 212, ABOUT 3.0 MI (4.8 KM) EAST OF WATERTOWN, GO WEST ON
AC7987'U.S. HIGHWAY 212 FOR 0.95 MI (1.53 KM) TO A DRIVEWAY AND THE STATION
AC7987'ON THE RIGHT. THE STATION IS 115.5 FT (35.2 M) NORTH OF THE HIGHWAY
AC7987'CENTERLINE, 26.5 FT (8.1 M) WEST OF A SIGN (ELMIRA 33-350), 20.5 FT
AC7987'(6.2 M) NORTHWEST OF THE NORTHWEST CORNER OF A CULVERT UNDER THE
AC7987'DRIVEWAY, AND 1.0 FT (0.3 M) SOUTH OF A WITNESS POST AND A FENCE.
AC7987'NOTE--ACCESS TO THE DATUM POINT IS THROUGH A 5-INCH LOGO CAP.
AC7987
AC7987 STATION RECOVERY (1996)
AC7987



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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AC7987'RECOVERY NOTE BY JE CHANCE AND ASSOCIATES 1996 (LH)
AC7987'1.5 KM (0.95 MI) WESTERLY ALONG U.S. HIGHWAY 212 FROM THE JUNCTION OF
AC7987'INTERSTATE HIGHWAY 29 IN WATERTOWN (EXIT 177), 348.0 M (1141.7 FT)
AC7987'WEST OF MILEPOST 379, 31.9 M (104.7 FT) NORTH OF THE CENTERLINE OF THE
AC7987'WESTBOUND LANES OF THE HIGHWAY, 10.1 M (33.1 FT) NORTHWEST OF THE
AC7987'CENTER OF A DRIVEWAY, 6.0 M (19.7 FT) WEST OF THE CENTER OF A FIELD
AC7987'ENTRANCE AND GATE, 0.4 M (1.3 FT) BELOW THE LEVEL OF THE HIGHWAY, AND
AC7987'0.3 M (1.0 FT) SOUTH OF A WITNESS POST AND FENCE. NOTE---ACCESS TO THE
AC7987'DATUM POINT IS THROUGH A 5-INCH LOGO CAP. THE SLEEVE DEPTH DOES NOT
AC7987'MEET THE SPECIFICATIONS FOR A CLASS A MARK.





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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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AC8003 CEN - This is a Cooperative Base Network Control Station.
AC8003 DESIGNATION - K 468
AC8003 PID - AC8003
AC8003 STATE/COUNTY- SD/SPINK
AC8003 USGS QUAD - DOLAND (1971)
AC8003
AC8003
AC8003 *CURRENT SURVEY CONTROL
AC8003
AC8003* NAD 83(2007)- 44 53 33.72036(N) 098 02 38.93491(W) ADJUSTED
AC8003* NAVD 88 - 420.348 (meters) 1379.09 (feet) ADJUSTED
AC8003
AC8003 EPOCH DATE - 2002.00
AC8003 X - -633,392.095 (meters) COMP
AC8003 Y - -4,481,758.897 (meters) COMP
AC8003 Z - 4,479,188.175 (meters) COMP
AC8003 LAPLACE CORR- -1.11 (seconds) DEFLEC09
AC8003 ELLIP HEIGHT- 395.903 (meters) (02/10/07) ADJUSTED
AC8003 GEOID HEIGHT- -24.45 (meters) GEOID09
AC8003 DYNAMIC HT - 420.301 (meters) 1378.94 (feet) COMP
AC8003
AC8003 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
AC8003 Type PID Designation North East Ellip
AC8003
AC8003 NETWORK AC8003 K 468 0.98 0.63 2.94
AC8003
AC8003 MODELED GRAV- 980,492.2 (mgal) NAVD 88
AC8003
AC8003 VERT ORDER - FIRST CLASS II
AC8003
AC8003.The horizontal coordinates were established by GPS observations
AC8003.and adjusted by the National Geodetic Survey in February 2007.
AC8003
AC8003.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AC8003.See [National Readjustment](#) for more information.
AC8003
AC8003.The horizontal coordinates are valid at the epoch date displayed above
AC8003.which is a decimal equivalence of Year/Month/Day.
AC8003
AC8003.The orthometric height was determined by differential leveling and
AC8003.adjusted in July 1998.
AC8003
AC8003.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AC8003
AC8003.The Laplace correction was computed from DEFLEC09 derived deflections.
AC8003
AC8003.The ellipsoidal height was determined by GPS observations
AC8003.and is referenced to NAD 83.
AC8003
AC8003.The geoid height was determined by GEOID09.
AC8003
AC8003.The dynamic height is computed by dividing the NAVD 88
AC8003.geopotential number by the normal gravity value computed on the
AC8003.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
AC8003.degrees latitude (g = 980.6199 gals.).
AC8003



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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AC8003'RAYMOND, 3.0 MI (4.8 KM) WEST OF THE SPINK/CLARK COUNTY LINE, AND 2.8
AC8003'MI (4.5 KM) EAST OF DOLAND, ON U.S. HIGHWAY 212. OWNERSHIP--THE STATE
AC8003'OF SOUTH DAKOTA. TO REACH THE STATION FROM THE JUNCTION OF U.S.
AC8003'HIGHWAY 212 AND STATE HIGHWAY 37 NORTH ON THE EAST SIDE OF DOLAND, GO
AC8003'EAST ON U.S. HIGHWAY 212 FOR 3.0 MI (4.8 KM) TO A GRAVEL ROAD LEFT
AC8003'(COUNTY ROAD 1) AND THE STATION ON LEFT. THE STATION IS LOCATED 89.3
AC8003'FT (27.2 M) NORTH OF THE HIGHWAY CENTERLINE, 53.2 FT (16.2 M)
AC8003'WEST-NORTHWEST OF A COUNTY ROAD SIGN, 35.1 FT (10.7 M) NORTH OF A
AC8003'FENCE CORNER, 35.0 FT (10.7 M) WEST OF THE GRAVEL ROAD CENTER, AND 1.7
AC8003'FT (0.5 M) EAST OF A WITNESS POST IN FENCE LINE. NOTE--ACCESS TO THE
AC8003'DATUM POINT IS THROUGH A 5-INCH LOGO CAP.

AC8003

STATION RECOVERY (1999)

AC8003

AC8003'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1999 (GAS)
AC8003'4.6 KM (2.85 MI) EASTERLY ALONG U.S. HIGHWAY 212 FROM THE JUNCTION OF
AC8003'HUMPHREY DRIVE IN DOLAND, 541.0 M (1774.9 FT) EAST OF MILEPOST 330,
AC8003'27.2 M (89.2 FT) NORTH OF THE HIGHWAY CENTERLINE, 10.8 M (35.4 FT)
AC8003'NORTH OF A FENCE CORNER, 10.5 M (34.4 FT) WEST OF THE CENTER OF COUNTY
AC8003'ROAD 1, 1.3 M (4.3 FT) BELOW THE LEVEL OF THE HIGHWAY, AND 0.5 M (1.6
AC8003'FT) EAST OF A WITNESS POST AND FENCE. NOTE--ACCESS TO THE DATUM POINT
AC8003'IS THROUGH A 5-INCH LOGO CAP. THE SLEEVE DEPTH DOES NOT MEET THE
AC8003'SPECIFICATIONS FOR A CLASS A MARK. THE MONUMENT IS ON COUNTY ROAD
AC8003'RIGHT-OF-WAY. THIS IS A COOPERATIVE BASE NETWORK CONTROL STATION.





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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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Q01162 *****
Q01162 CBN - This is a Cooperative Base Network Control Station.
Q01162 DESIGNATION - I90 346.9
Q01162 PID - Q01162
Q01162 STATE/COUNTY- SD/HANSON
Q01162 USGS QUAD - FARMER (1973)
Q01162
Q01162 *CURRENT SURVEY CONTROL
Q01162
Q01162* NAD 83(2007)- 43 39 58.08704(N) 097 43 45.64149(W) ADJUSTED
Q01162* NAVD 88 - 415.163 (meters) 1362.08 (feet) ADJUSTED
Q01162
Q01162 EPOCH DATE - 2002.00
Q01162 X - -621,555.780 (meters) COMP
Q01162 Y - -4,579,460.133 (meters) COMP
Q01162 Z - 4,381,601.178 (meters) COMP
Q01162 LAPLACE CORR- 1.88 (seconds) DEFLEC09
Q01162 ELLIP HEIGHT- 389.114 (meters) (02/10/07) ADJUSTED
Q01162 GEOID HEIGHT- -26.04 (meters) GEOID09
Q01162 DYNAMIC HT - 415.062 (meters) 1361.75 (feet) COMP
Q01162
Q01162 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
Q01162 Type PID Designation North East Ellip
Q01162 -----
Q01162 NETWORK Q01162 I90 346.9 0.92 0.61 2.98
Q01162 -----
Q01162 MODELED GRAV- 980,362.4 (mgal) NAVD 88
Q01162
Q01162 VERT ORDER - FIRST CLASS II
Q01162
Q01162.The horizontal coordinates were established by GPS observations
Q01162.and adjusted by the National Geodetic Survey in February 2007.
Q01162
Q01162.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
Q01162.See National Readjustment for more information.
Q01162
Q01162.The horizontal coordinates are valid at the epoch date displayed above
Q01162.which is a decimal equivalence of Year/Month/Day.
Q01162
Q01162.The orthometric height was determined by differential leveling and
Q01162.adjusted in September 1993.
Q01162
Q01162.The X, Y, and Z were computed from the position and the ellipsoidal ht.
Q01162
Q01162.The Laplace correction was computed from DEFLEC09 derived deflections.
Q01162
Q01162.The ellipsoidal height was determined by GPS observations
Q01162.and is referenced to NAD 83.
Q01162
Q01162.The geoid height was determined by GEOID09.
Q01162
Q01162.The dynamic height is computed by dividing the NAVD 88
Q01162.geopotential number by the normal gravity value computed on the
Q01162.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
Q01162.degrees latitude (g = 980.6199 gals.).
Q01162
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GDI #:368_SSD12-1 **Error! Reference source not found.**
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QQ1162.The modeled gravity was interpolated from observed gravity values.
QQ1162
QQ1162;
North East Units Scale Factor Converg.
QQ1162;SPC SD S - 151,354.497 809,969.709 MT 0.99990722 +1 47 46.9
QQ1162;SPC SD S - 496,568.88 2,657,375.62 sFT 0.99990722 +1 47 46.9
QQ1162;UTM 14 - 4,835,576.700 602,443.570 MT 0.99972908 +0 52 38.7
QQ1162
QQ1162! - Elev Factor x Scale Factor = Combined Factor
QQ1162!SPC SD S - 0.99993899 x 0.99990722 = 0.99984621
QQ1162!UTM 14 - 0.99993899 x 0.99972908 = 0.99966808
QQ1162
QQ1162 SUPERSEDED SURVEY CONTROL
QQ1162
QQ1162 ELLIP H (04/15/04) 389.105 (m) GP( ) 2 1
QQ1162 NAD 83(1996)- 43 39 58.08678(N) 097 43 45.64115(W) AD( ) B
QQ1162 ELLIP H (04/18/97) 389.140 (m) GP( ) 4 1
QQ1162 NAVD 88 (04/18/97) 415.16 (m) 1362.1 (f) LEVELING 3
QQ1162
QQ1162.Superseded values are not recommended for survey control.
QQ1162.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
QQ1162.See file dsdata.txt to determine how the superseded data were derived.
QQ1162
QQ1162.U.S. NATIONAL GRID SPATIAL ADDRESS: 14TPP0244335576(NAD 83)
QQ1162
QQ1162_MARKER: Z = SEE DESCRIPTION
QQ1162_SETTING: 57 = GALVANIZED STEEL PIPE IN SLEEVE (10 FT.+)
QQ1162_SP_SET: GALVANIZED STEEL PIPE IN SLEEV
QQ1162_STAMPING: I90 346.9
QQ1162_MARK LOGO: NGS
QQ1162_PROJECTION: FLUSH
QQ1162_MAGNETIC: P = MARKER IS A STEEL PIPE
QQ1162_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
QQ1162_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
QQ1162+SATELLITE: SATELLITE OBSERVATIONS - July 25, 1996
QQ1162_ROD/PIPE-DEPTH: 6.4 meters
QQ1162_SLEEVE-DEPTH : 1.8 meters
QQ1162
QQ1162 HISTORY - Date Condition Report By
QQ1162 HISTORY - 1990 MONUMENTED SDDT
QQ1162 HISTORY - 19910621 GOOD NGS
QQ1162 HISTORY - 19960725 GOOD NGS
QQ1162
QQ1162 STATION DESCRIPTION
QQ1162
QQ1162'DESCRIBED BY NATIONAL GEODETIC SURVEY 1991
QQ1162'4.6 KM (2.9 MI) EASTERLY ALONG INTERSTATE HIGHWAY 90 FROM THE
QQ1162'JUNCTION OF STATE HIGHWAY 262 (EXIT 344) IN ALEXANDRIA, A STAINLESS
QQ1162'STEEL BALL EPOXIED TO A PIPE CAP THAT IS ATTACHED TO A 1 1/2-INCH
QQ1162'GALVANIZED STEEL PIPE, 200.0 M (656.2 FT) WEST OF THE NORTHWEST
QQ1162'CORNER OF BRIDGE NUMBER 31-120-126, 31.5 M (103.3 FT) NORTH OF THE
QQ1162'CENTERLINE OF THE WESTBOUND LANES OF THE HIGHWAY, 11.5 M (37.7 FT)
QQ1162'EAST OF A BRACED FENCE POST, 2.0 M (6.6 FT) BELOW THE LEVEL OF THE
QQ1162'HIGHWAY, AND 0.4 M (1.3 FT) SOUTHWEST OF A WITNESS POST AND FENCE.
QQ1162'NOTE--ACCESS TO THE DATUM POINT IS THROUGH A 5-INCH LOGO CAP AND THEN
QQ1162'THROUGH A 4-INCH PVC CAP.

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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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OQ1162
OQ1162 STATION RECOVERY (1996)
OQ1162
OQ1162'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1996 (DFC)
OQ1162'THE STATION IS LOCATED ABOUT 3.0 MI (4.8 KM) EAST OF ALEXANDRIA, ON
OQ1162'INTERSTATE HIGHWAY 90. OWNERSHIP--THE STATE OF SOUTH DAKOTA. TO
OQ1162'REACH THE STATION FROM THE JUNCTION OF INTERSTATE HIGHWAY 90 AND STATE
OQ1162'HIGHWAY 262 (EXIT 344) IN ALEXANDRIA, GO EAST ON THE INTERSTATE
OQ1162'HIGHWAY FOR 2.9 MILES (4.7 KM) TO THE STATION ON THE LEFT. THE
OQ1162'STATION IS A PUNCH POINT ON TOP OF A STAINLESS STEEL RIVET FASTENED TO
OQ1162'A METAL PIPE CAP ATTACHED TO A 1 1/2-INCH GALVANIZED STEEL PIPE.
OQ1162'LOCATED 206.1 M (676.2 FT) WEST OF THE NORTHWEST CORNER OF A COUNTY
OQ1162'ROAD OVERPASS (NUMBER 31-120-126) OF THE HIGHWAY, 138.8 M (455.4 FT)
OQ1162'NORTHWEST OF MILEPOST 347, 31.4 M (103.0 FT) NORTH OF THE WESTBOUND
OQ1162'HIGHWAY CENTERLINE, 11.5 M (37.7 FT) EAST OF A BRACED FENCE POST, 2.0
OQ1162'M (6.6 FT) BELOW THE LEVEL OF THE HIGHWAY, 0.4 M (1.3 FT) NORTH OF A
OQ1162'METAL GUARD POST, 0.4 M (1.3 FT) SOUTH OF A WITNESS POST AND FENCE,
OQ1162'AND 0.1 M (0.3 FT) BELOW THE GROUND SURFACE. NOTE--ACCESS TO THE
OQ1162'DATUM POINT IS THROUGH A 5-INCH LOGO CAP AND THEN A 4-INCH PVC CAP.





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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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PR1027 *****
PR1027 CBN - This is a Cooperative Base Network Control Station.
PR1027 DESIGNATION - I29 120.1
PR1027 PID - PR1027
PR1027 STATE/COUNTY- SD/MOODY
PR1027 USGS QUAD - MEDARY (1981)
PR1027
PR1027 *CURRENT SURVEY CONTROL
PR1027
PR1027* NAD 83(2007)- 44 07 35.76384(N) 096 45 31.27516(W) ADJUSTED
PR1027* NAVD 88 - 513.020 (meters) 1683.13 (feet) ADJUSTED
PR1027
PR1027 EPOCH DATE - 2002.00
PR1027 X - -539,722.107 (meters) COMP
PR1027 Y - -4,554,172.948 (meters) COMP
PR1027 Z - 4,418,539.040 (meters) COMP
PR1027 LAPLACE CORR- -1.99 (seconds) DEFLEC09
PR1027 ELLIP HEIGHT- 487.210 (meters) (02/10/07) ADJUSTED
PR1027 GEOID HEIGHT- -25.80 (meters) GEOID09
PR1027 DYNAMIC HT - 512.907 (meters) 1682.76 (feet) COMP
PR1027
PR1027 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
PR1027 Type PID Designation North East Ellip
PR1027
PR1027 NETWORK PR1027 I29 120.1 0.61 0.47 2.04
PR1027
PR1027 MODELED GRAV- 980,382.5 (mgal) NAVD 88
PR1027
PR1027 VERT ORDER - FIRST CLASS II
PR1027
PR1027.The horizontal coordinates were established by GPS observations
PR1027.and adjusted by the National Geodetic Survey in February 2007.
PR1027
PR1027.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
PR1027.See National Readjustment for more information.
PR1027
PR1027.The horizontal coordinates are valid at the epoch date displayed above
PR1027.which is a decimal equivalence of Year/Month/Day.
PR1027
PR1027.The orthometric height was determined by differential leveling and
PR1027.adjusted in October 1997.
PR1027
PR1027.The X, Y, and Z were computed from the position and the ellipsoidal ht.
PR1027
PR1027.The Laplace correction was computed from DEFLEC09 derived deflections.
PR1027
PR1027.The ellipsoidal height was determined by GPS observations
PR1027.and is referenced to NAD 83.
PR1027
PR1027.The geoid height was determined by GEOID09.
PR1027
PR1027.The dynamic height is computed by dividing the NAVD 88
PR1027.geopotential number by the normal gravity value computed on the
PR1027.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
PR1027.degrees latitude (g = 980.6199 gals.).
PR1027
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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

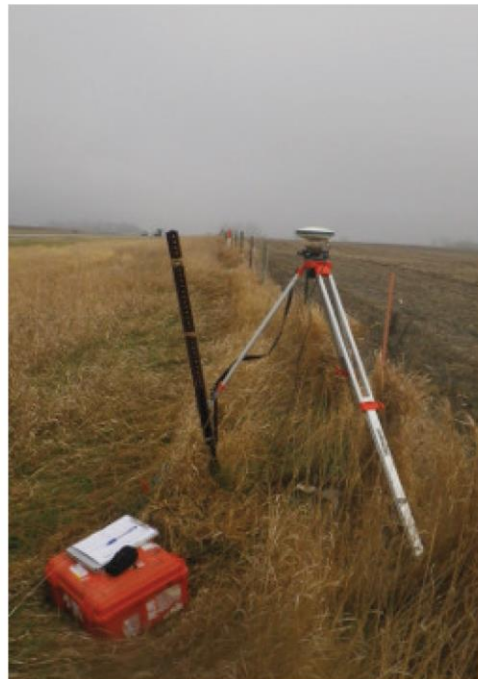
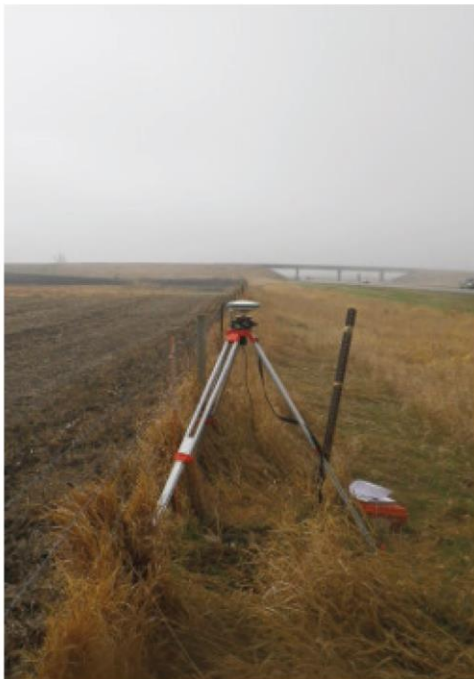
PR1027.The modeled gravity was interpolated from observed gravity values.
PR1027
PR1027;
PR1027;SPC SD S - North East Units Scale Factor Converg.
PR1027;SPC SD S - 205,376.587 885,994.664 MT 0.99994618 +2 27 57.5
PR1027;SPC SD S - 673,806.35 2,906,800.83 sFT 0.99994618 +2 27 57.5
PR1027;UTM 14 - 4,888,376.831 679,314.158 MT 0.99999546 +1 33 39.3
PR1027
PR1027! - Elev Factor x Scale Factor = Combined Factor
PR1027!SPC SD S - 0.99992361 x 0.99994618 = 0.99986979
PR1027!UTM 14 - 0.99992361 x 0.99999546 = 0.99991907
PR1027
PR1027 SUPERSEDED SURVEY CONTROL
PR1027
PR1027 ELLIP H (04/15/04) 487.235 (m) GP () 2 1
PR1027 NAD 83(1996)- 44 07 35.76338(N) 096 45 31.27439(W) AD () B
PR1027 ELLIP H (04/18/97) 487.242 (m) GP () 4 1
PR1027 NAVD 88 (04/18/97) 513.03 (m) 1683.2 (f) LEVELING 3
PR1027 NAVD 88 (06/15/91) 513.031 (m) 1683.17 (f) UNKNOWN 1 2
PR1027
PR1027.Superseded values are not recommended for survey control.
PR1027.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
PR1027.[See file dsdata.txt](#) to determine how the superseded data were derived.
PR1027
PR1027_U.S. NATIONAL GRID SPATIAL ADDRESS: 14TPP7931488376(NAD 83)
PR1027
PR1027_MARKER: Z = SEE DESCRIPTION
PR1027_SETTING: 57 = GALVANIZED STEEL PIPE IN SLEEVE (10 FT.)
PR1027_SP_SET: GALVANIZED STEEL PIPE IN SLEEV
PR1027_STAMPING: I29-120.1 1990
PR1027_MARK LOGO: NGS
PR1027_PROJECTION: FLUSH
PR1027_MAGNETIC: P = MARKER IS A STEEL PIPE
PR1027_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
PR1027_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
PR1027+SATELLITE: SATELLITE OBSERVATIONS - September 03, 2008
PR1027_ROD/PIPE-DEPTH: 6.4 meters
PR1027_SLEEVE-DEPTH : 1.8 meters
PR1027
PR1027 HISTORY - Date Condition Report By
PR1027 HISTORY - 1990 MONUMENTED SDDT
PR1027 HISTORY - 19900530 GOOD NGS
PR1027 HISTORY - 19960617 GOOD NGS
PR1027 HISTORY - 20080903 GOOD SDDT
PR1027
PR1027 STATION DESCRIPTION
PR1027
PR1027'DESCRIBED BY NATIONAL GEODETIC SURVEY 1990
PR1027'16.4 KM (10.2 MI) NORTHERLY ALONG INTERSTATE HIGHWAY 29 FROM ITS
PR1027'JUNCTION WITH STATE HIGHWAY 34 (COLEMAN EXIT 104), 0.35 KM (0.22 MI)
PR1027'NORTH OF THE INTERSECTION OF A COUNTY ROAD, 53.9 M (176.8 FT) SOUTH OF
PR1027'THE MOST SOUTHERLY OF 3 FENCE BRACE POSTS, 31.4 M (103.0 FT) EAST OF
PR1027'AND LEVEL WITH THE CENTERLINE OF THE NORTHBOUND LANES OF THE HIGHWAY,
PR1027'AND 0.4 M (1.3 FT) WEST OF A WITNESS POST AND FENCE. NOTE--THE DATUM
PR1027'POINT IS A STAINLESS STEEL BALL EPOXIED TO AN IRON PIPE CAP THAT IS
PR1027'ATTACHED TO A 1 1/2 INCH IRON PIPE. ACCESS TO THE DATUM POINT IS
PR1027'THROUGH A 5-INCH LOGO CAP AND THEN THROUGH A 4-INCH PVC SCREW CAP.



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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
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PR1027
PR1027 STATION RECOVERY (1996)
PR1027
PR1027'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1996 (DFC)
PR1027'THE STATION IS LOCATED ABOUT 10.2 MI (16.4 KM) NORTH OF THE JUNCTION
PR1027'OF INTERSTATE HIGHWAY 29 AND STATE HIGHWAY 34, ON INTERSTATE HIGHWAY
PR1027'29. OWNERSHIP--THE STATE OF SOUTH DAKOTA. TO REACH THE STATION FROM
PR1027'THE JUNCTION OF STATE HIGHWAY 34 AND INTERSTATE HIGHWAY 29 (COLEMAN
PR1027'EXIT 109), GO NORTH ALONG INTERSTATE 29 FOR 10.2 MI (16.4 KM) TO THE
PR1027'STATION ON THE RIGHT. THE STATION IS A PUNCH POINT ON TOP OF A
PR1027'STAINLESS STEEL RIVET FASTENED TO A METAL PIPE CAP ATTACHED TO A 1
PR1027'1/2-INCH GALVANIZED STEEL PIPE. LOCATED 0.35 KM (0.20 MI) NORTH OF
PR1027'THE INTERSECTION OF A COUNTY ROAD, 53.9 M (176.8 FT) SOUTH OF THE MOST
PR1027'SOUTHERLY OF 3 BRACED FENCE POSTS, 31.4 M (103.0 FT) EAST OF AND LEVEL
PR1027'WITH THE CENTERLINE OF THE NORTHBOUND HIGHWAY, AND 0.4 M (1.3 FT) WEST
PR1027'OF A WITNESS POST AND FENCE. NOTE--ACCESS TO THE DATUM POINT IS
PR1027'THROUGH A 5-INCH LOGO CAP AND THEN A 4-INCH PVC CAP.
PR1027
PR1027 STATION RECOVERY (2008)
PR1027
PR1027'RECOVERY NOTE BY SD DEPT OF TRANSP 2008 (KHG)
PR1027'RECOVERED AS DESCRIBED





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GDI #:368_SSD12-1 **Error! Reference source not found.**
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PR1071 *****
PR1071 CBN - This is a Cooperative Base Network Control Station.
PR1071 DESIGNATION - I29 148.00
PR1071 PID - PR1071
PR1071 STATE/COUNTY- SD/BROOKINGS
PR1071 USGS QUAD - ESTELLINE SE (1981)
PR1071
PR1071 *CURRENT SURVEY CONTROL
PR1071
PR1071 NAD 83(2007)- 44 31 53.59710(N) 096 45 23.46307(W) ADJUSTED
PR1071 NAVD 88 - 534.214 (meters) 1752.67 (feet) ADJUSTED
PR1071
PR1071 EPOCH DATE - 2002.00
PR1071 X - -535,851.842 (meters) COMP
PR1071 Y - -4,522,981.421 (meters) COMP
PR1071 Z - 4,450,745.575 (meters) COMP
PR1071 LAPLACE CORR- -2.90 (seconds) DEFLEC09
PR1071 ELLIP HEIGHT- 509.188 (meters) (02/10/07) ADJUSTED
PR1071 GEOID HEIGHT- -25.04 (meters) GEOID09
PR1071 DYNAMIC HT - 534.126 (meters) 1752.38 (feet) COMP
PR1071
PR1071 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
PR1071 Type PID Designation North East Ellip
PR1071
PR1071 NETWORK PR1071 I29 148.00 0.45 0.33 1.10
PR1071
PR1071 MODELED GRAV- 980,435.7 (mgal) NAVD 88
PR1071
PR1071 VERT ORDER - FIRST CLASS II
PR1071
PR1071 The horizontal coordinates were established by GPS observations
PR1071 and adjusted by the National Geodetic Survey in February 2007.
PR1071
PR1071 The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
PR1071 See National Readjustment for more information.
PR1071
PR1071 The horizontal coordinates are valid at the epoch date displayed above
PR1071 which is a decimal equivalence of Year/Month/Day.
PR1071
PR1071 The orthometric height was determined by differential leveling and
PR1071 adjusted in October 1997.
PR1071
PR1071 The X, Y, and Z were computed from the position and the ellipsoidal ht.
PR1071
PR1071 The Laplace correction was computed from DEFLEC09 derived deflections.
PR1071
PR1071 The ellipsoidal height was determined by GPS observations
PR1071 and is referenced to NAD 83.
PR1071
PR1071 The geoid height was determined by GEOID09.
PR1071
PR1071 The dynamic height is computed by dividing the NAVD 88
PR1071 geopotential number by the normal gravity value computed on the
PR1071 Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
PR1071 degrees latitude (g = 980.6199 gals.).
PR1071
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Report

GDI #:368_SSD12-1 **Error! Reference source not found.**
Error! Reference source not found.

PR1071.The modeled gravity was interpolated from observed gravity values.
PR1071
PR1071;
PR1071;SPC SD N - North East Units Scale Factor Converg.
PR1071;SPC SD N - 82,751.839 857,739.444 MT 0.99997997 +2 17 43.9
PR1071;SPC SD N - 271,494.99 2,814,100.16 sFT 0.99997997 +2 17 43.9
PR1071;UTM 14 - 4,933,362.334 678,256.401 MT 0.99999077 +1 34 25.6
PR1071
PR1071! - Elev Factor x Scale Factor = Combined Factor
PR1071!SPC SD N - 0.99992017 x 0.99997997 = 0.99990014
PR1071!UTM 14 - 0.99992017 x 0.99999077 = 0.99991094
PR1071
PR1071 SUPERSEDED SURVEY CONTROL
PR1071
PR1071 ELLIP H (04/15/04) 509.180 (m) GP () 2 1
PR1071 NAD 83(1996)- 44 31 53.59657(N) 096 45 23.46230(W) AD () B
PR1071 ELLIP H (04/18/97) 509.187 (m) GP () 4 1
PR1071 NAVD 88 (07/31/03) 534.21 (m) 1752.7 (f) LEVELING 3
PR1071 NAVD 88 (04/18/97) 534.23 (m) 1752.7 (f) LEVELING 3
PR1071 NAVD 88 (06/15/91) 534.228 (m) 1752.71 (f) UNKNOWN 1 2
PR1071
PR1071.Superseded values are not recommended for survey control.
PR1071.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
PR1071.[See file dsdata.txt](#) to determine how the superseded data were derived.
PR1071
PR1071_U.S. NATIONAL GRID SPATIAL ADDRESS: 14TPQ7825633362(NAD 83)
PR1071
PR1071_MARKER: Z = SEE DESCRIPTION
PR1071_SETTING: 57 = GALVANIZED STEEL PIPE IN SLEEVE (10 FT.+)
PR1071_SP_SET: GALVANIZED STEEL PIPE IN SLEEV
PR1071_STAMPING: 29-148.00
PR1071_MARK LOGO: NGS
PR1071_PROJECTION: FLUSH
PR1071_MAGNETIC: P = MARKER IS A STEEL PIPE
PR1071_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
PR1071_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
PR1071+SATELLITE: SATELLITE OBSERVATIONS - 2002
PR1071_ROD/PIPE-DEPTH: 6.4 meters
PR1071_SLEEVE-DEPTH : 1.8 meters
PR1071
PR1071 HISTORY - Date Condition Report By
PR1071 HISTORY - UNK MONUMENTED SDDT
PR1071 HISTORY - 19900703 GOOD NGS
PR1071 HISTORY - 19960623 GOOD NGS
PR1071 HISTORY - 2002 GOOD MNDDT
PR1071
PR1071 STATION DESCRIPTION
PR1071
PR1071'DESCRIBED BY NATIONAL GEODETIC SURVEY 1990
PR1071'24.5 KM (15.2 MI) NORTHERLY ALONG INTERSTATE HIGHWAY 29 FROM ITS
PR1071'JUNCTION WITH U.S. HIGHWAY 14 (EXIT 132) IN BROOKINGS, 31.8 M
PR1071'(104.3 FT) EAST OF THE CENTERLINE OF THE NORTHBOUND LANES OF THE
PR1071'HIGHWAY, 30.4 M (99.7 FT) SOUTH OF THE MOST SOUTHERLY OF 2 FENCE
PR1071'BRACE POSTS, 19.6 M (64.3 FT) EAST OF MILEPOST 148, 10.7 M (35.1 FT)
PR1071'NORTHWEST OF AN IRRIGATION WELL, 2.5 M (8.2 FT) BELOW THE LEVEL OF THE
PR1071'HIGHWAY, AND 0.35 M (1.15 FT) WEST OF A WITNESS POST AND FENCE.
PR1071'FENCE. NOTE--THE DATUM POINT IS A STAINLESS STEEL BALL EPOXIED TO AN
PR1071'IRON PIPE CAP THAT IS ATTACHED TO A 1 1/2 INCH IRON PIPE. ACCESS TO



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PR1071'THE DATUM POINT IS THROUGH A 5-INCH LOGO CAP AND THEN THROUGH A
PR1071'4-INCH PVC SCREW CAP.
PR1071
PR1071 STATION RECOVERY (1996)
PR1071
PR1071'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1996 (DFC)
PR1071'THE STATION IS LOCATED ABOUT 15.0 MI (24.1 KM) NORTH OF BROOKINGS, 8.0
PR1071'MI (12.9 KM) SOUTHEAST OF ESTILLINE, AND 0.8 MI (1.3 KM) SOUTH OF THE
PR1071'DEUEL/BROOKINGS COUNTY LINE ON INTERSTATE HIGHWAY 29. OWNERSHIP--THE
PR1071'STATE OF SOUTH DAKOTA. TO REACH THE STATION FROM THE JUNCTION OF
PR1071'INTERSTATE HIGHWAY 29 AND U.S. HIGHWAY 14 (EXIT 132) IN BROOKINGS, GO
PR1071'NORTH ON INTERSTATE HIGHWAY 29 FOR 24.5 KM (15.20 MI) TO THE STATION
PR1071'ON THE RIGHT. THE STATION IS A PUNCH POINT ON TOP OF A STAINLESS
PR1071'STEEL RIVET FASTENED TO A METAL PIPE CAP ATTACHED TO A 1 1/2-INCH
PR1071'GALVANIZED STEEL PIPE. LOCATED 31.8 M (104.3 FT) EAST OF THE
PR1071'CENTERLINE OF THE NORTHBOUND HIGHWAY, 30.4 M (99.7 FT) SOUTH OF THE
PR1071'MOST SOUTHERLY OF 2 BRACED FENCE POSTS, 19.6 M (64.3 FT) EAST OF
PR1071'MILEPOST 148, 2.5 M (8.2 FT) BELOW THE LEVEL OF THE HIGHWAY, 0.3 M
PR1071'(1.0 FT) EAST OF A METAL GUARD POST, AND 0.3 M (1.0 FT) WEST OF A
PR1071'WITNESS POST AND FENCE. NOTE--ACCESS TO THE DATUM POINT IS THROUGH A
PR1071'5-INCH LOGO CAP AND THEN A 4-INCH PVC CAP.
PR1071
PR1071 STATION RECOVERY (2002)
PR1071
PR1071'RECOVERY NOTE BY MN DEPT OF TRANSP 2002 (DKH)
PR1071'RECOVERED AS DESCRIBED.





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QQ0640 *****
QQ0640 CBN - This is a Cooperative Base Network Control Station.
QQ0640 DESIGNATION - I29 207.50
QQ0640 PID - QQ0640
QQ0640 STATE/COUNTY- SD/ROBERTS
QQ0640 USGS QUAD - SUMMIT (1970)
QQ0640
QQ0640 *CURRENT SURVEY CONTROL
QQ0640
QQ0640* NAD 83(2007)- 45 18 59.38655(N) 097 02 59.00413(W) ADJUSTED
QQ0640* NAVD 88 - 614.979 (meters) 2017.64 (feet) ADJUSTED
QQ0640
QQ0640 EPOCH DATE - 2002.00
QQ0640 X - -551,436.899 (meters) COMP
QQ0640 Y - -4,459,097.843 (meters) COMP
QQ0640 Z - 4,512,570.456 (meters) COMP
QQ0640 LAPLACE CORR- -3.49 (seconds) DEFLEC09
QQ0640 ELLIP HEIGHT- 589.670 (meters) (02/10/07) ADJUSTED
QQ0640 GEOID HEIGHT- -25.32 (meters) GEOID09
QQ0640 DYNAMIC HT - 614.909 (meters) 2017.41 (feet) COMP
QQ0640
QQ0640 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----
QQ0640 Type PID Designation North East Ellip
QQ0640
QQ0640 NETWORK QQ0640 I29 207.50 0.71 0.59 2.37
QQ0640
QQ0640 MODELED GRAV- 980,482.2 (mgal) NAVD 88
QQ0640
QQ0640 VERT ORDER - FIRST CLASS II
QQ0640
QQ0640.The horizontal coordinates were established by GPS observations
QQ0640.and adjusted by the National Geodetic Survey in February 2007.
QQ0640
QQ0640.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
QQ0640.See [National Readjustment](#) for more information.
QQ0640
QQ0640.The horizontal coordinates are valid at the epoch date displayed above
QQ0640.which is a decimal equivalence of Year/Month/Day.
QQ0640
QQ0640.The orthometric height was determined by differential leveling and
QQ0640.adjusted in July 1998.
QQ0640
QQ0640.The X, Y, and Z were computed from the position and the ellipsoidal ht.
QQ0640
QQ0640.The Laplace correction was computed from DEFLEC09 derived deflections.
QQ0640
QQ0640.The ellipsoidal height was determined by GPS observations
QQ0640.and is referenced to NAD 83.
QQ0640
QQ0640.The geoid height was determined by GEOID09.
QQ0640

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QQ0640.The dynamic height is computed by dividing the NAVD 88
QQ0640.geopotential number by the normal gravity value computed on the
QQ0640.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
QQ0640.degrees latitude (g = 980.6199 gals.).
QQ0640
QQ0640.The modeled gravity was interpolated from observed gravity values.
QQ0640
QQ0640;           North           East           Units Scale Factor Converg.
QQ0640;SPC SD N   -   169,028.980   831,272.945   MT   0.99994981   +2 05 16.9
QQ0640;SPC SD N   -   554,555.91   2,727,267.99   sFT  0.99994981   +2 05 16.9
QQ0640;UTM 14     -   5,019,960.222   652,862.755   MT   0.99988731   +1 23 12.9
QQ0640
QQ0640!           -   Elev Factor   x   Scale Factor   =   Combined Factor
QQ0640!SPC SD N   -   0.99990756   x   0.99994981   =   0.99985737
QQ0640!UTM 14     -   0.99990756   x   0.99988731   =   0.99979488
QQ0640
QQ0640                               SUPERSEDED SURVEY CONTROL
QQ0640
QQ0640 ELLIP H (04/15/04) 589.697 (m) GP( ) 2 1
QQ0640 NAD 83(1996)- 45 18 59.38605(N) 097 02 59.00365(W) AD( ) B
QQ0640 ELLIP H (04/18/97) 589.711 (m) GP( ) 4 1
QQ0640 NAVD 88 (04/18/97) 614.97 (m) 2017.6 (f) LEVELING 3
QQ0640 NAVD 88 (06/15/91) 614.969 (m) 2017.61 (f) UNKNOWN 1 2
QQ0640
QQ0640.Superseded values are not recommended for survey control.
QQ0640.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
QQ0640.See file dsdata.txt to determine how the superseded data were derived.
QQ0640
QQ0640_U.S. NATIONAL GRID SPATIAL ADDRESS: 14TPR5286219960(NAD 83)
QQ0640
QQ0640_MARKER: Z = SEE DESCRIPTION
QQ0640_SETTING: 57 = GALVANIZED STEEL PIPE IN SLEEVE (10 FT.+)
QQ0640_SP_SET: GALVANIZED STEEL PIPE IN SLEEVE
QQ0640_STAMPING: 29-207.50
QQ0640_MARK LOGO: NGS
QQ0640_PROJECTION: FLUSH
QQ0640_MAGNETIC: P = MARKER IS A STEEL PIPE
QQ0640_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD
QQ0640+STABILITY: POSITION/ELEVATION WELL
QQ0640_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
QQ0640+SATELLITE: SATELLITE OBSERVATIONS - May 20, 1997
QQ0640_ROD/PIPE-DEPTH: 6.4 meters
QQ0640_SLEEVE-DEPTH : 1.8 meters
QQ0640
QQ0640 HISTORY - Date Condition Report By
QQ0640 HISTORY - UNK MONUMENTED SDDT
QQ0640 HISTORY - 19900721 GOOD NGS
QQ0640 HISTORY - 19900725 GOOD NGS
QQ0640 HISTORY - 19960712 GOOD NGS
QQ0640 HISTORY - 19970520 GOOD NGS
QQ0640
QQ0640
QQ0640                               STATION DESCRIPTION
QQ0640
QQ0640'DESCRIBED BY NATIONAL GEODETIC SURVEY 1990
QQ0640'0.2 KM (0.1 MI) NORTHERLY ALONG INTERSTATE HIGHWAY 29 FROM THE
QQ0640'JUNCTION OF U.S. HIGHWAY 12 (SUMMIT EXIT 207), 128.0 M (419.9 FT)

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QQ0640'EAST OF THE CENTERLINE OF THE NORTHBOUND LANES OF THE HIGHWAY, 59.0 M
QQ0640'(193.6 FT) NORTHEAST OF THE CENTER OF THE NORTHBOUND ON RAMP, 7.9 M
QQ0640'(25.9 FT) NORTH-NORTHWEST OF THE NORTHWESTERLY OF 6 FENCE BRACE POST,
QQ0640'6.0 M (19.7 FT) ABOVE THE LEVEL OF THE HIGHWAY, 0.5 M (1.6 FT)
QQ0640'SOUTHWEST OF A FENCE, AND 0.4 M (1.3 FT) NORTHEAST OF A WITNESS POST.
QQ0640'NOTE--THE DATUM POINT IS A STAINLESS STEEL BALL EPOXIED TO AN IRON
QQ0640'PIPE CAP THAT IS ATTACHED TO A 1 1/2 INCH IRON PIPE. ACCESS TO THE
QQ0640'DATUM POINT IS THROUGH A 5-INCH LOGO CAP AND THEN THROUGH A 4-INCH
QQ0640'PVC SCREW CAP.
QQ0640
QQ0640 STATION RECOVERY (1990)
QQ0640
QQ0640'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1990
QQ0640'RECOVERED IN GOOD CONDITION.
QQ0640
QQ0640 STATION RECOVERY (1996)
QQ0640
QQ0640'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1996 (DPC)
QQ0640'THE STATION IS LOCATED ABOUT 2.0 MI (3.2 KM) WEST OF SUMMIT, ALONG THE
QQ0640'INTERSTATE HIGHWAY 29 NORTHBOUND ON-RAMP AT EXIT 207. OWNERSHIP--THE
QQ0640'STATE OF SOUTH DAKOTA. TO REACH THE STATION FROM THE JUNCTION OF
QQ0640'INTERSTATE HIGHWAY 29 AND U.S. HIGHWAY 12 (EXIT 207) WEST OF SUMMIT,
QQ0640'GO EAST OF U.S. HIGHWAY 12 FOR 0.1 MI (0.2 KM) TO THE NORTHBOUND
QQ0640'INTERSTATE HIGHWAY ON-RAMP, TURN LEFT AND GO NORTH ON THE RAMP FOR 0.2
QQ0640'MI (0.3 KM) TO THE STATION ON THE RIGHT. THE STATION IS A PUNCH POINT
QQ0640'ON TOP OF A STAINLESS STEEL RIVET FASTENED TO A METAL PIPE CAP
QQ0640'ATTACHED TO A 1 1/2-INCH GALVANIZED STEEL PIPE. LOCATED 129.8 M
QQ0640'(425.9 FT) EAST OF THE CENTERLINE OF THE NORTHBOUND LANES OF THE
QQ0640'HIGHWAY, 58.7 M (192.6 FT) NORTHEAST OF THE CENTER OF THE RAMP, 10.0 M
QQ0640'(32.8 FT) ABOVE THE LEVEL OF THE RAMP, 0.5 M (1.6 FT) SOUTHWEST OF A
QQ0640'WITNESS POST AND FENCE, AND 0.4 M (1.3 FT) NORTHEAST OF A METAL GUARD
QQ0640'POST. NOTE--ACCESS TO THE DATUM POINT IS THROUGH A 5-INCH LOGO CAP
QQ0640'AND THEN A 4-INCH PVC CAP.
QQ0640
QQ0640 STATION RECOVERY (1997)
QQ0640
QQ0640'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (GAS)
QQ0640'0.2 KM (0.10 MI) NORTHERLY ALONG INTERSTATE HIGHWAY 29 FROM THE
QQ0640'JUNCTION OF U.S. HIGHWAY 12 AT SUMMIT (EXIT 207), 128.0 M (419.9 FT)
QQ0640'EAST OF THE CENTERLINE OF THE NORTHBOUND LANES OF THE HIGHWAY, 59.0 M
QQ0640'(193.6 FT) NORTHEAST OF THE CENTER OF THE NORTHBOUND ON RAMP, 7.7 M
QQ0640'(25.3 FT) NORTHWEST OF THE NORTHWEST END OF 6 BRACED FENCE POSTS, 6.0
QQ0640'M (19.7 FT) ABOVE THE LEVEL OF THE HIGHWAY, 0.5 M (1.6 FT) SOUTHWEST
QQ0640'OF A FENCE, AND 0.4 M (1.3 FT) NORTHEAST OF A WITNESS POST. NOTE--THE
QQ0640'DATUM POINT IS A STAINLESS STEEL RIVET AFFIXED TO A STEEL PIPE CAP
QQ0640'THAT IS ATTACHED TO A 1 1/2-INCH GALVANIZED STEEL PIPE. ACCESS TO THE
QQ0640'DATUM POINT IS THROUGH A 5-INCH LOGO CAP AND THEN THROUGH A 4-INCH PVC
QQ0640'CAP. THE MONUMENT IS A SOUTH DAKOTA HARN STATION.








STATION DESCRIPTION FORM

PROJECT No.: 368SSD12
PROJECT NAME: South dakota
LOCATION: Kingsbury County

PHOTOS TAKEN:

STATION NAME: 368SSD-01	MARKER TYPE: Rebar 0.5" x 3.0'	DATE: April 2012
STATION NUMBER: 368SSD-01	STATION LOCALITY: Kingsbury County South Dakota	LEGAL DESCRIPTION:
DATUM: NAD 83	CENTRAL MERIDIAN: 99	UTM ZONE: 14
LATITUDE: N 44 16 04.38891	LONGITUDE: W 097 33 06.78382	ELLIPSOID HEIGHT metres (h): 474.059
UTM NORTHING metres: 4 902 646.783	UTM EASTING metres: 615 578.056	GEOID HEIGHT metres (MSL): 499.355
MONUMENT IS: <input type="checkbox"/> FLUSH WITH GROUND <input type="checkbox"/> ABOVE GROUND _____ cm <input type="checkbox"/> BELOW GROUND _____ cm		
MARKER LOCATION: Inside the road allowance approx 2 meters from a fence post perpendicular to the fence line.		
DIAGRAM (Include Ties to Relevant Features)		
		
		





STATION DESCRIPTION FORM

PROJECT No.: 368SSD12
PROJECT NAME: South dakota
LOCATION: Sanborn County

PHOTOS TAKEN:

STATION NAME: 368SSD-02	MARKER TYPE: Brass Cap on Post	DATE: April 2012
STATION NUMBER: 368SSD-02	STATION LOCALITY: Sanborn County South Dakota	LEGAL DESCRIPTION:
DATUM: NAD 83	CENTRAL MERIDIAN: 99	UTM ZONE: 14
LATITUDE: N 44 11 03.94262	LONGITUDE: W 098 17 28.79747	ELLIPSOID HEIGHT metres (h): 375.767
UTM NORTHING metres: 4 892 601.383	UTM EASTING metres: 556 640.383	GEOID HEIGHT metres (MSL): 401.025

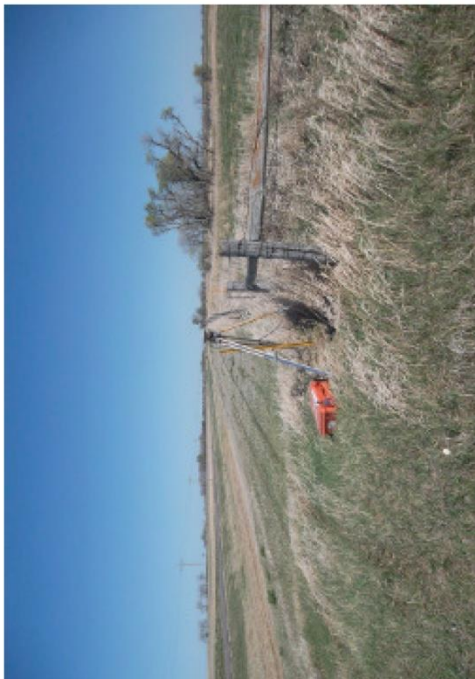
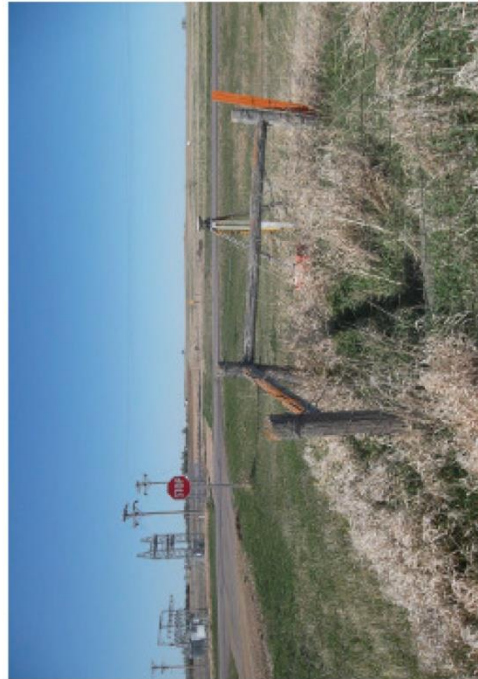
MONUMENT IS: ☐ FLUSH WITH GROUND ☐ ABOVE GROUND _____ cm ☐ BELOW GROUND _____ cm

MARKER LOCATION:

On the East side of 396th Ave /South side of Hwy 224, the point is a South Dakota Survey Ref marker.

DIAGRAM (Include Ties to Relevant Features)








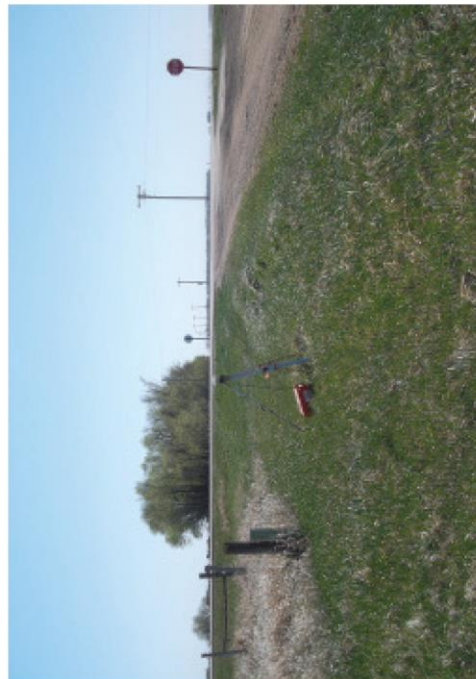


STATION DESCRIPTION FORM

PROJECT No.: 368SSD12
PROJECT NAME: South dakota
LOCATION: Spink County

PHOTOS TAKEN:

STATION NAME: 368SSD-03	MARKER TYPE: Rebar 0.5" x 4.0'	DATE: April 2012
STATION NUMBER: 368SSD-03	STATION LOCALITY: Spink County South Dakota	LEGAL DESCRIPTION:
DATUM: NAD 83	CENTRAL MERIDIAN: 99	UTM ZONE: 14
LATITUDE: N 44 37 58.96122	LONGITUDE: W 098 18 05.66949	ELLIPSOID HEIGHT metres (h): 370.369
UTM NORTHING metres: 4 942 424.864	UTM EASTING metres: 555 396.832	GEOID HEIGHT metres (MSL): 394.888
MONUMENT IS: <input type="checkbox"/> FLUSH WITH GROUND <input type="checkbox"/> ABOVE GROUND _____ cm <input type="checkbox"/> BELOW GROUND _____ cm		
MARKER LOCATION: In road allowance opposite a utility marker (wooden post).		
DIAGRAM (Include Ties to Relevant Features)		
		
 		





STATION DESCRIPTION FORM

PROJECT No.: 368SSD12
PROJECT NAME: South dakota
LOCATION: Sanborn County

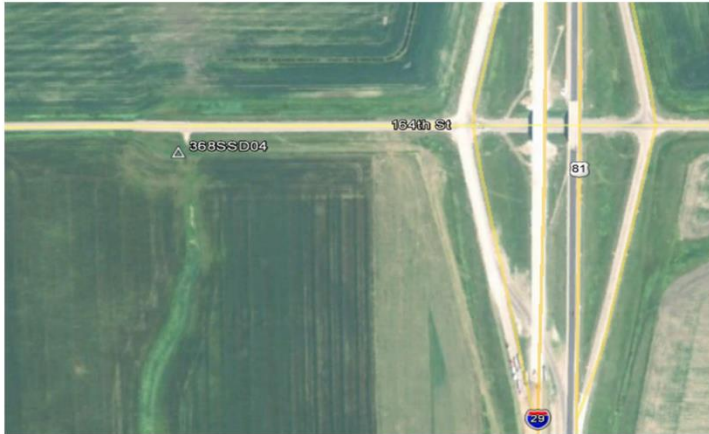
PHOTOS TAKEN:



STATION NAME: 368SSD-04	MARKER TYPE: 1/2" x 4' Re-bar	DATE: April 2012
STATION NUMBER: 368SSD-04	STATION LOCALITY: Codington County South Dakota	LEGAL DESCRIPTION:
DATUM: NAD 83	CENTRAL MERIDIAN: 99	UTM ZONE: 14
LATITUDE: N 45 00 20.58849	LONGITUDE: W 097 03 31.99780	ELLIPSOID HEIGHT metres (h): 534.667
UTM NORTHING metres: 4 985 418.566	UTM EASTING metres: 652 974.114	GEOID HEIGHT metres (MSL): 559.859

MONUMENT IS: ☐ FLUSH WITH GROUND ☐ ABOVE GROUND _____ cm ☐ BELOW GROUND _____ cm

MARKER LOCATION:
On the south side of County Rd 164 st inside the County Rd allowance, west of an entrance to a cultivated field, set 2 m opposite an existing fence post.

DIAGRAM (Include Ties to Relevant Features)










STATION DESCRIPTION FORM

PROJECT No.: 368SSD12
PROJECT NAME: South dakota
LOCATION: Davison County

PHOTOS TAKEN:

STATION NAME: 368SSD-05	MARKER TYPE: 1/2 "x 4' Rebar	DATE: 23 April 2012
STATION NUMBER: 368SSD-05	STATION LOCALITY: Davison, South Dakota	LEGAL DESCRIPTION:
DATUM: NAD 83	CENTRAL MERIDIAN: 99	UTM ZONE: 14
LATITUDE: 43 42 07.73595	LONGITUDE: 098 08 51.49130	ELLIPSOID HEIGHT metres (h): 388.644
UTM NORTHING metres: 4 839 145.003	UTM EASTING metres: 568 678.546	GEOID HEIGHT metres (MSL): 414.814
MONUMENT IS: <input type="checkbox"/> FLUSH WITH GROUND <input type="checkbox"/> ABOVE GROUND _____ cm <input type="checkbox"/> BELOW GROUND _____ cm		
MARKER LOCATION: Approx 1 m North from a fence post and 5m east of an access way to a cultivated field		
DIAGRAM (Include Ties to Relevant Features)		
		
		








STATION DESCRIPTION FORM

PROJECT No.: 368SSD12
PROJECT NAME: South dakota
LOCATION: Hutchinson County

PHOTOS TAKEN:

STATION NAME: 368SSD-06	MARKER TYPE: 1/2 " Rebar x 4 '	DATE: 23 April 2012
STATION NUMBER: 368SSD-06	STATION LOCALITY: Huchinson, South Dakota	LEGAL DESCRIPTION:
DATUM: NAD 83	CENTRAL MERIDIAN: 99	UTM ZONE: 14
LATITUDE: N 43 24 00.35765	LONGITUDE: W 097 41 41.48358	ELLIPSOID HEIGHT metres (h): 375.846
UTM NORTHING metres: 4 806 073.853	UTM EASTING metres: 605 687.776	GEOID HEIGHT metres (MSL): 402.019
MONUMENT IS: <input type="checkbox"/> FLUSH WITH GROUND <input type="checkbox"/> ABOVE GROUND _____ cm <input type="checkbox"/> BELOW GROUND _____ cm		
MARKER LOCATION: Approx 1 m North from a fence post and 9m east of an access way to a cultivated field		
<p>DIAGRAM (Include Ties to Relevant Features)</p>   		





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